STANDARDS DEVELOPMENT BRANCH OMOE
36936000004327

CLOSED WASTE SITE
EVALUATION
EMSDALE LANDFILL

OCTOBER 1989

MINISTRY OF THE ENVIRONMENT
WASTE MANAGEMENT BRANCH
LIBRARY

Environment
Ontario

Jim Bradley
Minister

TD
795.7
.C56
1989
MOE

TD
795.7
.C56
1989

Closed waste site evaluation :
emsdale landfill /

76704

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact Service Ontario Publications at copyright@ontario.ca

ISBN 0-7729-6173-5

CLOSED WASTE SITE EVALUATION

EMSDALE LANDFILL

Report prepared for:
Waste Site Evaluation Unit
Waste Management Branch

Report prepared by:
Morrison Beatty Limited

OCTOBER 1989

RECYCLABLE

Copyright: Queen's Printer for Ontario, 1989
This publication may be reproduced for non-commercial purposes
with appropriate attribution.

DISCLAIMER

This report was prepared for the Ontario Ministry of the Environment as part of a ministry-funded project. The views and ideas expressed in this report are those of the author and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

1.1 Purpose and Scope 1
1.2 Background 3

2.0 STUDY METHODS 6

3.0 PHYSICAL SETTING 7

3.1 Climate 7
3.2 Physiography 7
3.3 Regional Geology 9
3.4 Regional Hydrogeology 9

4.0 SITE SETTING 11

4.1 Site Development 11
4.2 Geology 13
4.3 Hydrogeology 16
4.4 Groundwater Quality 20

5.0 IMPACT ASSESSMENT 24

5.1 Groundwater Contamination 24

6.0 FUTURE WORK REQUIREMENTS 28

7.0 CONCLUSIONS 29

8.0 RECOMMENDATIONS 30

LIST OF FIGURES

			Page
Figure 1	-	Topographic Location	2
Figure 2	-	Airphoto Location	4
Figure 3	-	Physiography	8
Figure 4	-	Regional Cross-Section	10
Figure 5	-	Waste Location Plan	12
Figure 6	-	Site Plan	14
Figure 7	-	Cross-Sections B-B,' C-C' and D-D'	(Pocket)
Figure 8	-	Water Table Map	17
Figure 9	-	Potentiometric Surface	18

APPENDICES

Appendix A - Study Methods
Appendix B - MoE Background Data
Appendix C - Private Well Log Summary
Appendix D - Borehole and Test Pit Logs
Appendix E - Grain Size Curves
Appendix F - Field Monitoring Data
Appendix G - Water Quality

EXECUTIVE SUMMARY

As part of the MoE Closed Waste Site Evaluation Program, a hydrogeologic study was completed at the Emsdale Landfill (C of A #522502). The purpose of the investigation was to document the physical setting and evaluate the impact of the site on local water resources. The movement of landfill gases at the site were also studied.

The site is located in Perry Township, about 28 km north of Huntsville, Ontario. It was in operation before 1972 and closed during the mid-1970's. It is located on a 24 ha land parcel of which only about 1.5 ha was actually used for waste disposal. Domestic refuse is buried in random trenches across the property. Open burning was practiced, reducing waste volumes and the amount of organic material. The largest fill area occurs near the west side of the property.

In 1972 wastes from a train derailment at Novar were brought on-site under MoE supervision. As a result, there have been concerns about the effect of leachate on local groundwater quality since there are a number of downgradient groundwater users.

The site is located in a sandy environment and was operated concurrently as a landfill and as a sand and gravel pit. Although much of the aggregate has been removed, there is still aggregate extraction on-going at the northeast part of the property.

The results of the study show that most of the waste is buried in shallow trenches or pits that are generally above the water table. Leachate production occurs primarily as a result of precipitation infiltrating into the waste.

MINISTRY OF THE ENVIRONMENT
WASTE MANAGEMENT BRANCH
LIBRARY

Groundwater flow at the site is generally eastward toward Hwy. 11, following the slope of the ground surface. In situ hydraulic conductivity testing showed the on-site soils have a bulk hydraulic conductivity ranging from 1.5×10^{-6} to 1.7×10^{-3} cm/sec. Estimates of the average linear groundwater velocities range from 142 m/yr to about 2 m/yr.

Groundwater quality testing identified a relatively weak leachate in the vicinity of the derailment wastes. Across the rest of the site, there is little evidence to indicate leachate is adversely affecting groundwater quality. Field testing of private wells found no indication of groundwater contamination.

Because of the past practice of burning at the landfill, much of the waste needed to generate landfill gases has been destroyed. Therefore, the production and migration of landfill gases is not a problem.

Recommendations for future work include isolating, securing, and marking the train derailment waste area. Because of the very low potential for future effects on groundwater quality, there is no need for an on-going water quality monitoring program.

1.0 INTRODUCTION

Under authorization from the Waste Management Branch (WMB) of the Ministry of the Environment (MoE), Morrison Beatty Limited (MBL) conducted a hydrogeologic study at the Emsdale Landfill Site (C of A #522502). The site is located in Lot 13, Concession 11, of Perry Township, about 28 km north of the Town of Huntsville. The property is currently owned by the Township of Perry. Figure 1 shows the site location.

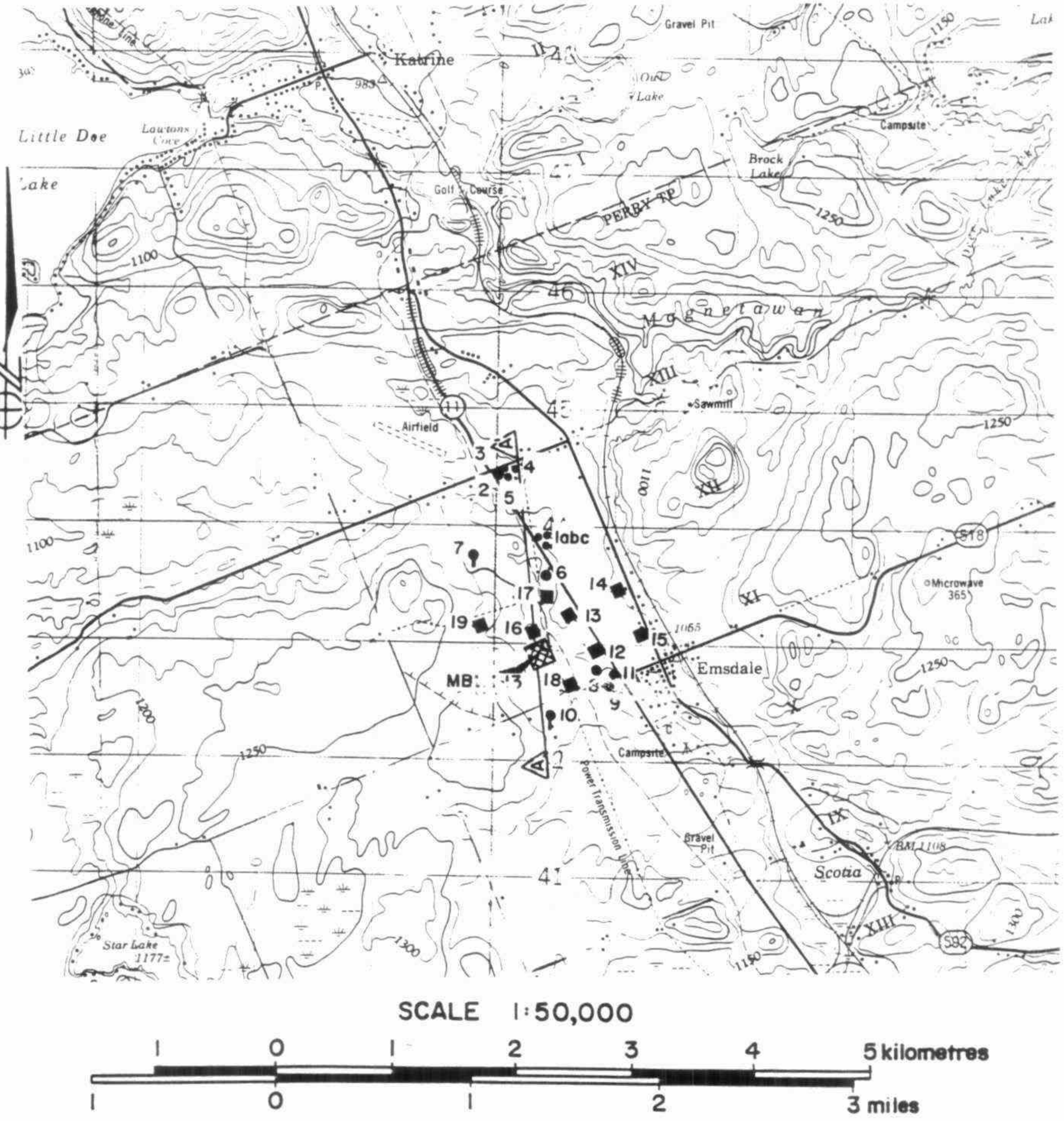
The study was completed as part of an on-going MoE assessment of closed waste disposal sites in Ontario. The initial phases of the study were completed by WMB. Stage I involved an inventory of all closed waste disposal sites in the province and verifying the inventory. Stage II was a preliminary data review and site reconnaissance to classify the site and establish the need for further study. Based on these results, several sites were identified as needing site-specific hydrogeologic investigations. The Emsdale landfill was selected for the third stage of work.

This study is part of the third stage of the program. It is a baseline hydrogeologic study to evaluate site conditions and assess the effects of each site on human health and safety and the physical environment.

1.1 Purpose and Scope

The overall purpose for the hydrogeologic study at the Emsdale landfill is to evaluate existing and potential future risks to human health and safety and the physical environment. The objectives for the study include:

- determining the physical setting and hydrogeologic conditions at the site
- identifying existing and potential future impacts on local water resources
- determining the extent of landfill gas-related hazards at the site
- determining the overall limits of the fill and identifying off-site movement of leachate
- providing recommendations for future work that will result in improvements to site conditions.



LEGEND

- ●1 Drilled overburden well
- ⚲7 Drilled bedrock well
- ■14 Shallow dug or bored well
- ▲—▲ Cross section line

MINISTRY of the ENVIRONMENT
Waste Management Branch

Closed Landfill Study
Emsdale Landfill

TOPOGRAPHIC LOCATION

PROJECT No. 628-881	FEB., 1989
	1

To achieve these objectives a hydrogeologic study was completed in sufficient detail to ensure that impacts from the site were evaluated. The study included:

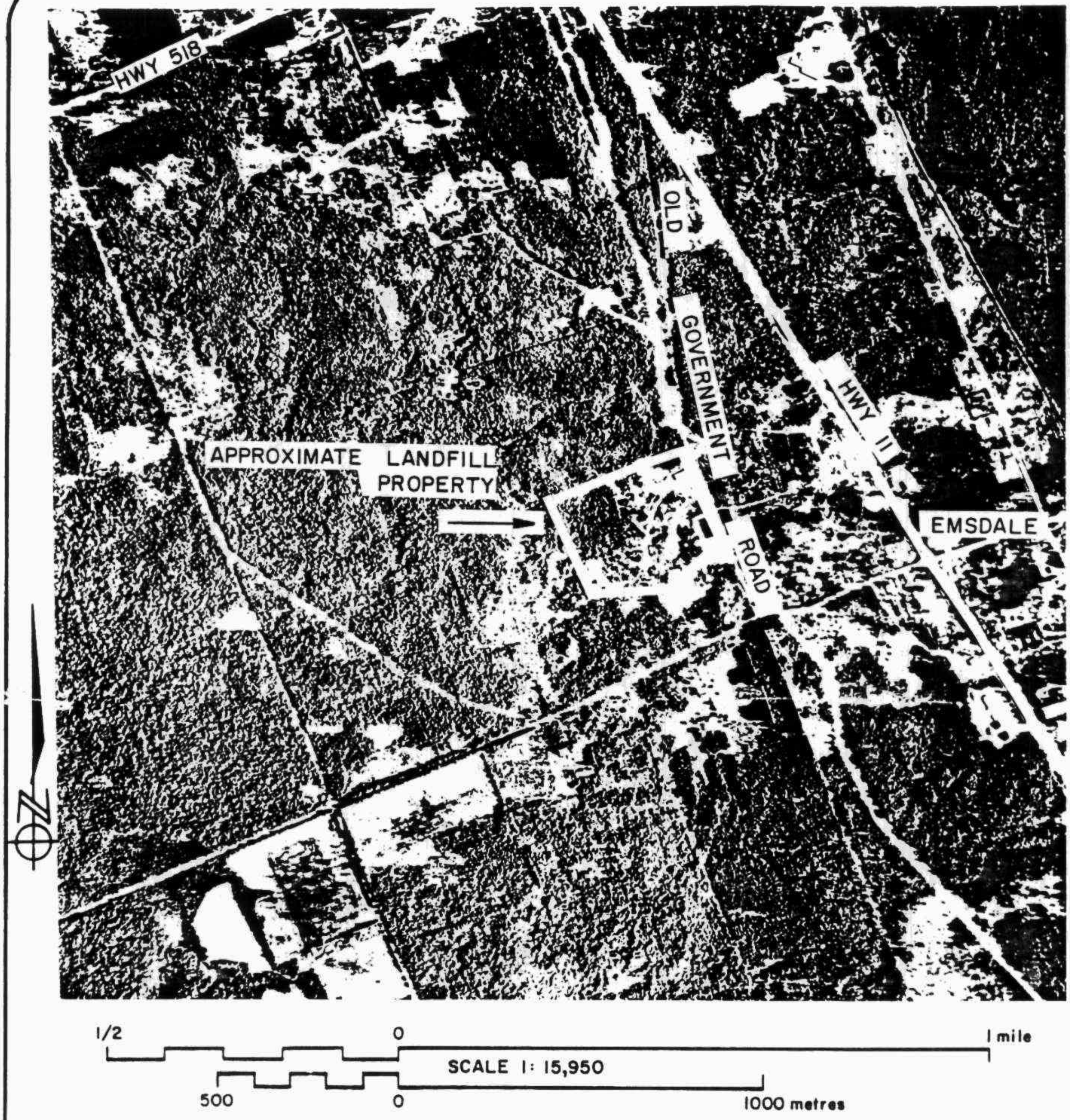
- collecting baseline data to identify site stratigraphy, aquifers and the relationship between the disposal site and its physical environment
- documenting local groundwater and surface water uses
- characterizing leachate quality
- evaluating the effect of the site on local water resources
- characterizing the effect of landfill gases on the physical environment.

This report presents the results of the hydrogeologic study. The first two chapters discuss background conditions and study methods. Chapters 3 and 4 document the physical setting, and site conditions. The effects of the landfill on the local environment and an overall environmental assessment is described in Chapter 5. Chapter 6 presents suggestions for future work at the site. A summary of our conclusions are presented in Chapter 7 followed by recommendations for site improvements in Chapter 8.

1.2 Background

The Emsdale landfill began operation prior to 1972. Waste disposal at the site ended during the mid to late 1970's. The site was developed in a sand and gravel pit on land owned by Perry Township. Throughout much of its history, the site was concurrently operated as a sand and gravel operation and landfill. To date, sand and gravel continues to be extracted from the northeast corner of the property.

The site is about 24 ha in size. The actual area used for waste disposal is not clearly document; however, it appears that about 1.5 ha of land has been used for waste disposal. It should be noted that Perry Township also owns the property north of the landfill. Figure 2 shows an airphoto plan of the site and its surrounding area.



MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

AIRPHOTO LOCATION

PROJECT No. 628-881

FEB., 1989

2

Wastes were placed in trenches located randomly across the property. Throughout the site operation, burning of refuse was practiced. Therefore, the majority of the waste left on-site appears to be non-combustible wastes and ash. The main waste disposal area is near the west side of the site.

In 1972, a train derailment occurred at Novar, south of Emsdale. Wastes from the derailment were transferred to the Emsdale landfill under supervision of the MoE. The waste products brought on site included:

- borax
- caustic soda
- soda ash
- mangcobar
- pyrite
- kwik seal
- spearesiene

The materials were deposited in trenches about 3 m wide and 1.6 m deep. The trenches were backfilled with local sandy fill material.

Little documentation exists about the deposition of the wastes at the Emsdale landfill. However, because the derailment wastes were considered a hazardous material, they were reportedly (MoE files) placed in a plastic lined trench.

Discussions with Perry Township staff and those involved with the original placement of the derailment waste revealed uncertainty about the trench liner.

Exact waste quantities were not documented; however, based on MoE background information, it appears that caustic soda was the only waste brought to the site in significant quantity.

2.0 STUDY METHODS

The hydrogeologic study for the Emsdale landfill was completed in three phases. Phase I involved the collection and review of existing geological and hydrogeological data; a review of information on file with the MoE; conducting a local water use survey; a site reconnaissance visit; and, the development of a health and safety program. Based on the results of the Phase I study, the site instrumentation and testing phase was reviewed and modified to ensure adequate testing to evaluate site conditions.

Test pitting, on-site observation well construction, surface and groundwater sampling and on-site testing completed Phase II. This phase also included some mapping of the landfill site and surrounding area. Monitoring for combustible gases during the drilling showed no evidence of landfill generated gases. Because of the waste deposited and the operation methods, the remoteness of the site and the lack of evidence that significant levels of landfill gases exist, no gas probes were constructed.

The results of both Phase I and Phase II were evaluated to determine the effect of the site on local water resources. The predicted future impact of the site was also examined. The result of the Phase III data evaluation is a series of recommendations for site improvements.

Details regarding the specific procedures and protocols followed for the site investigation are presented in Appendix A. Appendix B contains some of the correspondence and background information obtained from the MoE (North Bay District) files related to on-site monitoring and the placement of train derailment wastes. Appendices C through G present the results of on-site testing, hydrogeologic information and laboratory test results.

3.0 PHYSICAL SETTING

3.1 Climate

Data compiled for the Huntsville Meteorological Station showed the study area receives a mean annual precipitation of about 971 mm. On average September and November are the wettest months receiving between 97 and 101 mm of precipitation per month. The driest period occurs between February and May when an average 64 mm of precipitation occurs monthly.

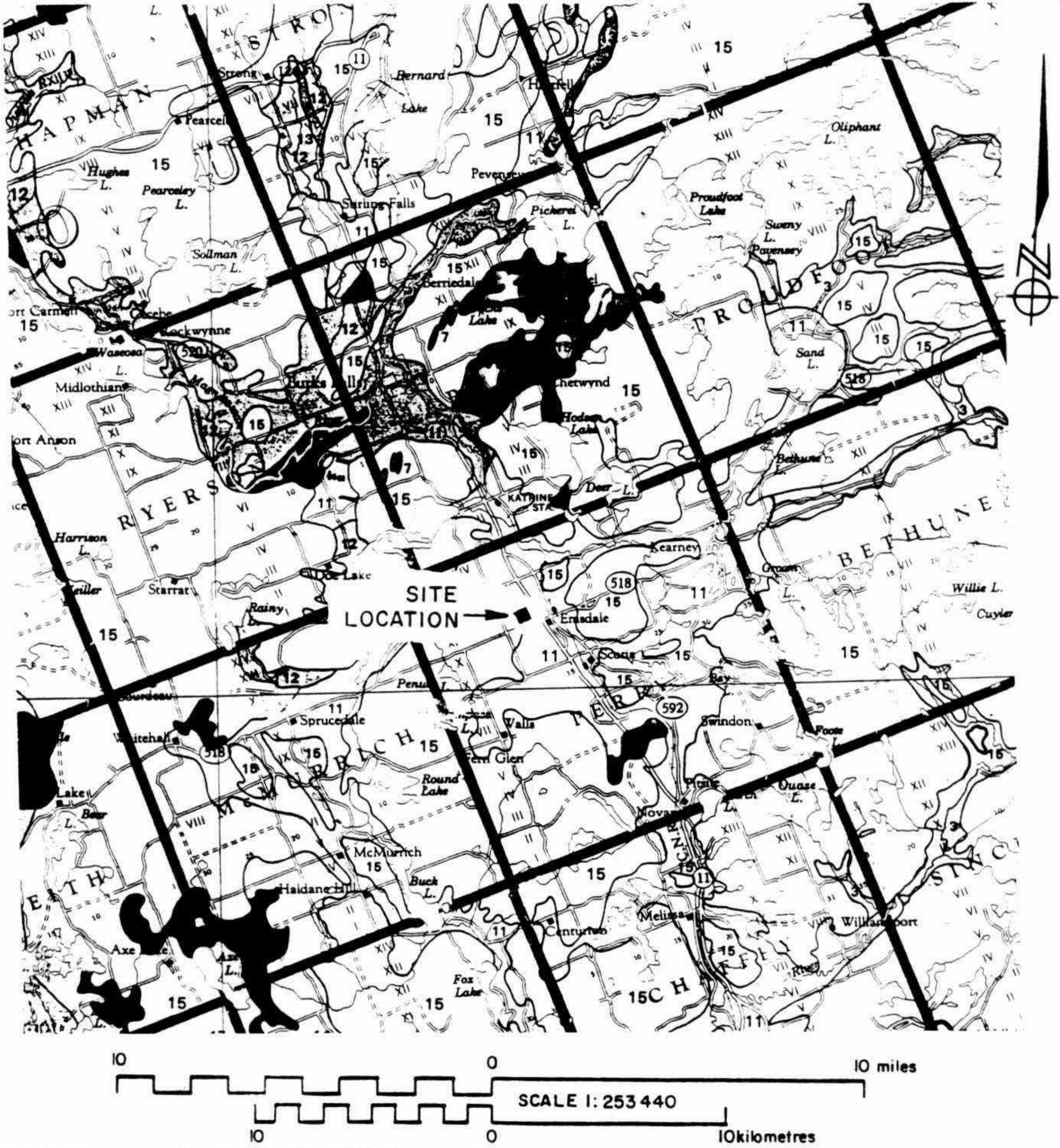
The mean annual temperature for the area is about 5.2° C. Mean monthly temperatures range from a low of -10.4° C in January to a high of 19.1° C in July.

3.2 Physiography

The Emsdale landfill is located in an area known as the No. 11 Strip Physiographic Region. The Hwy. 11 strip extends from Gravenhurst north to North Bay. It is characterized as a narrow strip of land in which sand, silt and clay deposits occupy bedrock hollows.

Locally, the relief ranges from 0 to 60 m. The topography is generally rolling to rough with rounded knobs and some rock ridges. Bedrock outcrops are frequent towards the fringes of the No. 11 strip but bedrock generally occurs at some depth toward the centre of the physiographic region.

Throughout the region, fluvial activity and meltwaters from the glaciers deposited kames and eskers of predominantly sand and gravel materials. They have been the source of many gravel pits along the Hwy. 11 alignment particularly at Powassen, Novar, Emsdale and Scotia. Figure 3 shows the general physiography of the area.



LEGEND

4	KAME MORAINE
11	SAND PLAIN
12	CLAY PLAIN
13	ESKER
15	SHALLOW TILL & ROCK RIDGE
17	PEAT & MUCK

From: Chapman,1975; physiography of the Georgian Bay-Ottawa Valley area; Ontario Ministry of Natural Resources; Map no. 2228.

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

PHYSIOGRAPHY

PROJECT No. 628-881

FEB.,1989

morrison beatty limited
consulting engineers and hydrogeologists

3

3.3 Regional Geology

The study area is located within the Grenville Province of the Canadian Shield. Bedrock in the area is Precambrian aged metasediments and metavolcanics. Granite is the predominant rock type with sporadic occurrences of volcanics and sylnites.

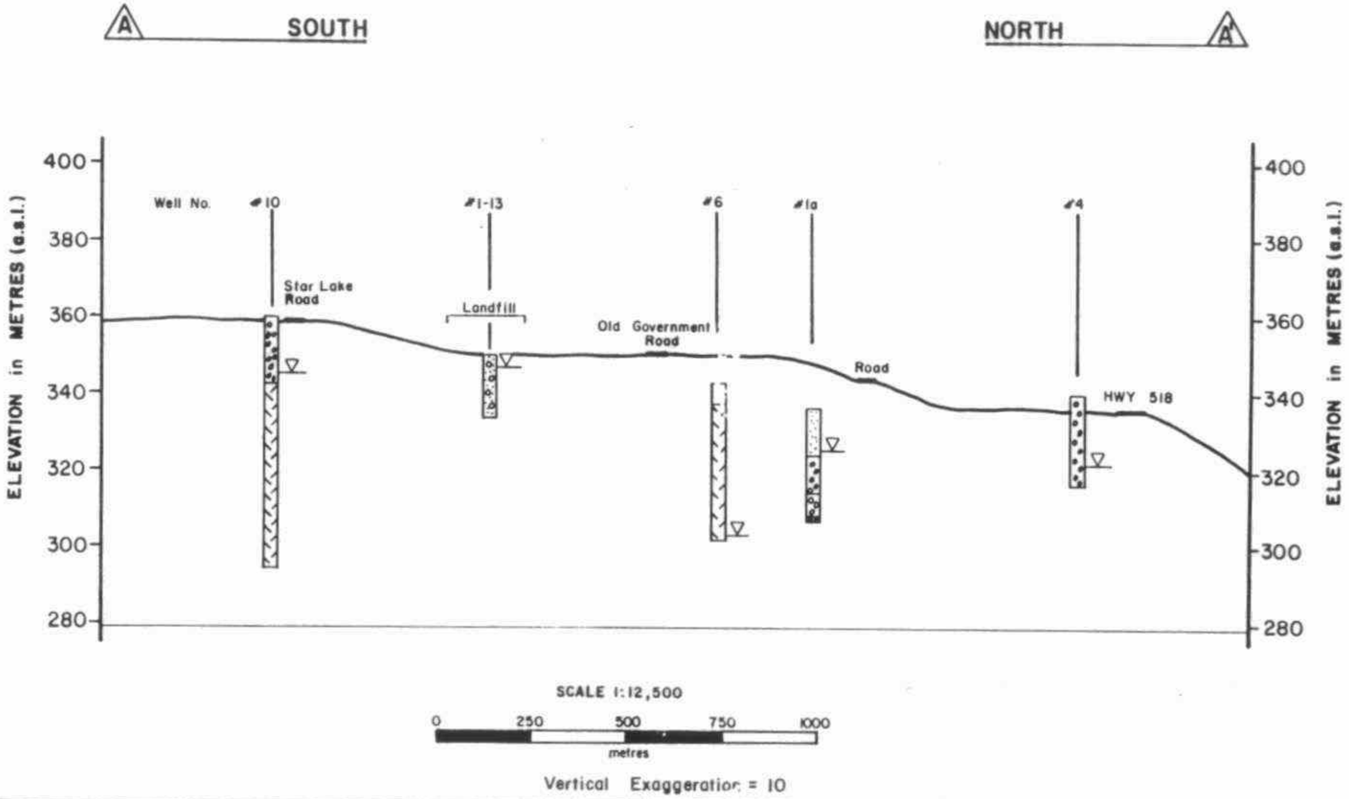
Bedrock outcrops are frequent towards the fringes of the Hwy. 11 strip, occurring as knobs and ridges. The hollows between these bedrock highs often contain overburden deposits exceeding 50 m thick. As a result of the rugged bedrock topography, the depth to rock surface can vary greatly over short distances.

The overburden in the study area ranges from deltaic and kame-like granular deposits to deeper water deposits of silts and clays. These deposits are the result of receding glaciers during the latter part of the Wisconsinan period. Figure 4 presents a north-south cross-section through the study area.

3.4 Regional Hydrogeology

The study area is located within the Great Lakes drainage basin. More specifically, the site is within the Magnetawan River drainage basin. The Magnetawan flows westerly towards Georgian Bay and Lake Huron. Locally, small tributaries tend to flow northward via small lakes and swamps to the Magnetawan before eventually discharging to Lake Huron.

In the bedrock, groundwater movement occurs primarily along discontinuities such as fractures, faults and bedding planes. These structural features, along with bedrock topography, control the movement of groundwater in the rock. In general, groundwater movement is westward towards Georgian Bay and Lake Huron. Local deviations to this flow occur near lakes and rivers.

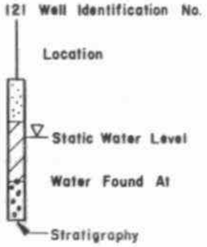


LEGEND

▨ SAND

○ GRAVEL

▧ GRANITE



MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

REGIONAL CROSS SECTION

PROJECT No. 628-881	FEB., 1989
	4

In the overburden, groundwater movement occurs primarily in sand and gravel deposits that infill bedrock hollows. The rough bedrock topography and variation in soil types results in large local variations in groundwater movement.

Private water supplies are locally obtained from both the sand and gravel overburden and the bedrock. Typical overburden well yields range from 13 to 65 m^3/day. Bedrock wells tend to yield toward the lower end of this range. Figure 1, (page 2) shows the private well locations and Appendix C presents a summary of the local well records.

4.0 SITE SETTING

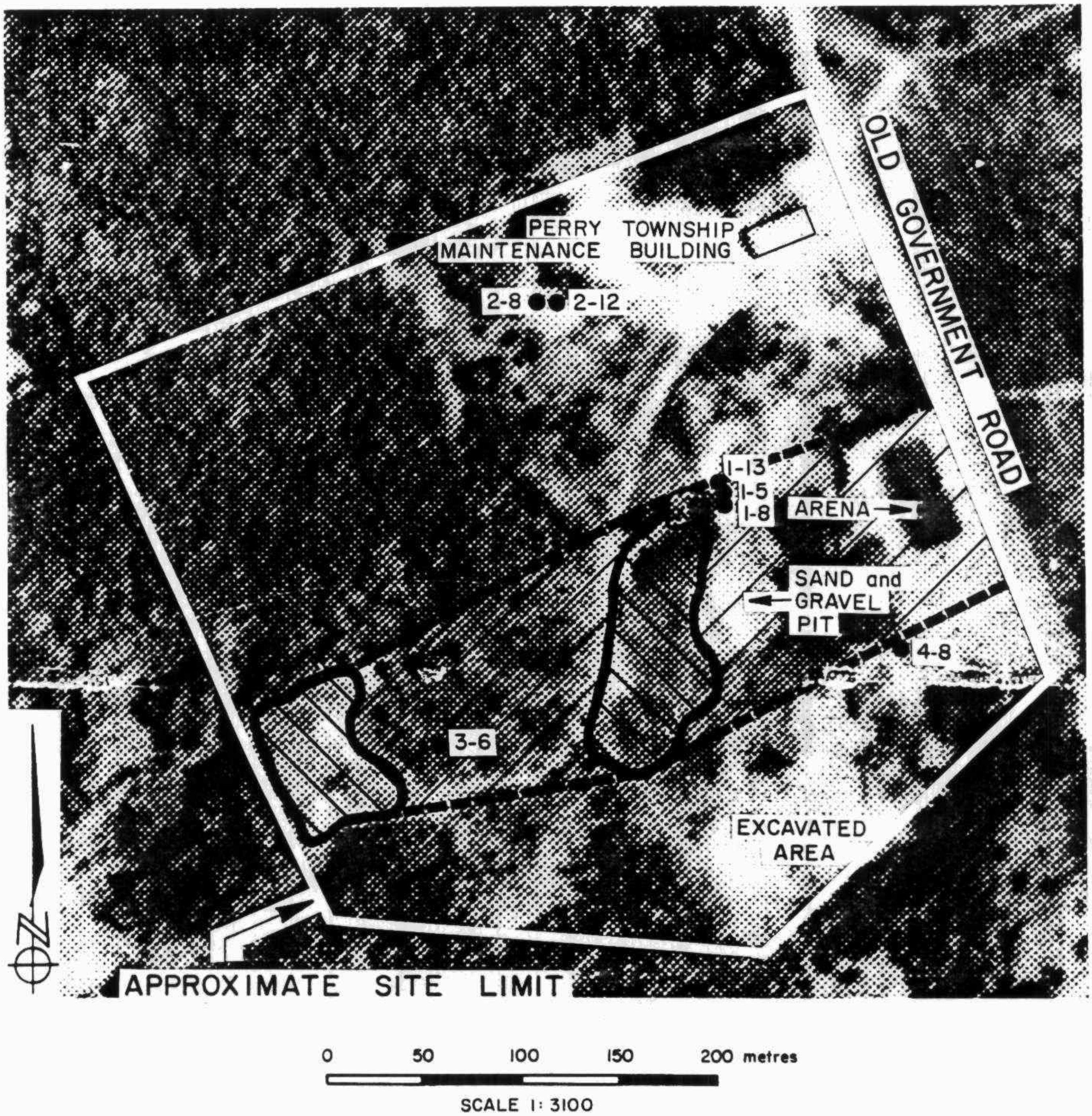
The Emsdale landfill is located in an area of moderate to high relief that is well drained. Surface runoff is generally low and the baseflow in local streams is derived primarily from local groundwater discharges.

4.1 Site Development

The Emsdale landfill was operated as a domestic waste disposal site to service Perry Township and the Village of Emsdale. Although the original site was about 24 ha in size, waste disposal occurred mainly in two general areas totally about 1.5 ha. Figure 5 shows the approximate waste disposal areas at the site on an enlarged airphoto base.

The property is partially cleared, as it was concurrently operated as a sand and gravel pit. The extraction of sand and gravel continues towards the northeast end of the property.

The landfill was a trench and fill operation. As additional capacity was needed, extra trenches were excavated. The disposal areas are not well defined and there are no operation records. The remnants of domestic refuse deposition, however, was encountered during test pit digging.



LEGEND

● Observation well location

▨ Approximate limit of domestic waste

☒ Approximate limit of train derailment wastes

⬚ On-Site area downgradient from known waste deposits

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

WASTE LOCATION PLAN

PROJECT No. 628-881	FEB., 1989
	5

As previously noted, wastes from a 1972 train derailment at Novar were disposed of at the Emsdale site under MoE supervision. The location of the train derailment wastes was difficult to determine because no documentation exists. Test pitting during the Phase I and II studies identified the general area where caustic soda and other chemicals were placed in a trench and subsequently covered. The disposal area currently is covered with waste brush and stumps. Figure 5 shows the approximate limits of the derailment waste.

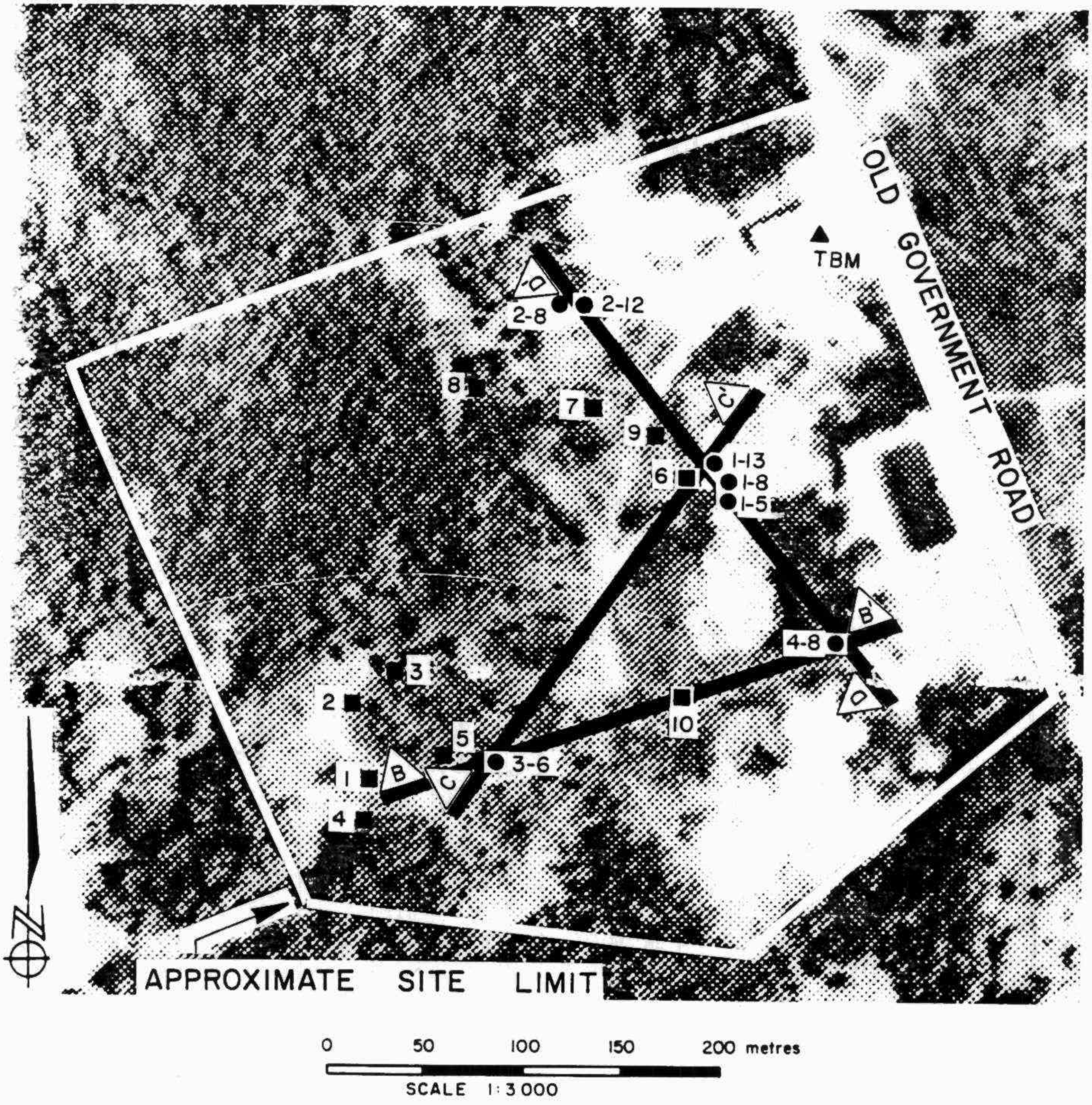
During both the test pitting and test drilling, no specific evidence of the derailment wastes was observed. The location of the waste is based on visual inspection of a pit side in the area where the wastes were reportedly encountered during gravel extraction. At present, the area is isolated from the gravel pit by windrows of gravel, concrete, and waste asphalt.

4.2 Geology

A total of 7 test wells were drilled and constructed at four locations. Also, 9 test pits or trenches were excavated to examine the shallow subsurface and attempt to locate the derailment wastes. Figure 6 shows the on-site testing locations.

Bedrock

Although numerous large boulders are exposed at ground surface towards the west-central portion of the property, bedrock was not confirmed during the test pitting or drilling program. Boreholes at some locations exceeded 12 m in depth with no confirmed bedrock. It should be noted that the large boulders encountered at the ground surface exceed 2 m in diameter. Because bedrock was not encountered, the thickness of overburden and the bedrock type could not be confirmed; however, it is interpreted that the bedrock is the Precambrian aged granites typical of the area.



LEGEND

● 2-8	Observation well
C C'	Cross section line (see Fig. 7, map pocket)
▲ TBM	Temporary Bench Mark (assumed elevation 100.00m)
■ 3	Test pit

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

SITE PLAN

PROJECT No. 628-881
FEB., 1989

6

Overburden

The surficial soil at the study site is predominantly sand with clay, silt and boulders. Typically, the formation becomes siltier with depth. In the upper 5 m, numerous large boulders exist. Boulders greater than 1.5 m in diameter were frequently encountered during the test drilling.

Test pits excavated towards the west end of the site encountered numerous large boulders within a sandy matrix. Appendix D presents a summary of the test pit logs and detailed well logs for on-site observation wells. The stratigraphy at the site did not substantially vary across the property. The silty sand formation exists at each test drilling location. Figure 7, (back pocket) presents three cross-sections through the study site.

Physical Properties

Well testing was conducted on each observation well to determine the in situ hydraulic conductivity of the formations encountered. The results show that hydraulic conductivities range from 1.5 x 10^{-6} cm/sec for the silty sand to 1.7 x 10^{-3} cm/sec for the medium to coarse sands at the west end of the property. The results of the hydraulic conductivity testing are summarized in Table F-1, Appendix F. Individual baildown test results are presented in Figures F-2 to F-8.

Grain size testing of samples collected during the test drilling show the sands and gravels at the site were made up of about 0 to 25% gravel, 70 to 80% sand, 5 to 35% silt, and less than 10% clay. The individual grain size distribution curves for samples selected for grain size distribution testing are presented in Figures E-2 to E-9, Appendix E.

4.3 Hydrogeology

Drainage

The site is situated on the east flank of a north-south trending ridge. The ground surface slopes eastward toward Emsdale. Because of the permeable surficial soils, the site is well drained with no standing water at natural ground surface. There are no surface water courses on-site. Ponded water is only evident at the base of excavations that have penetrated below the water table.

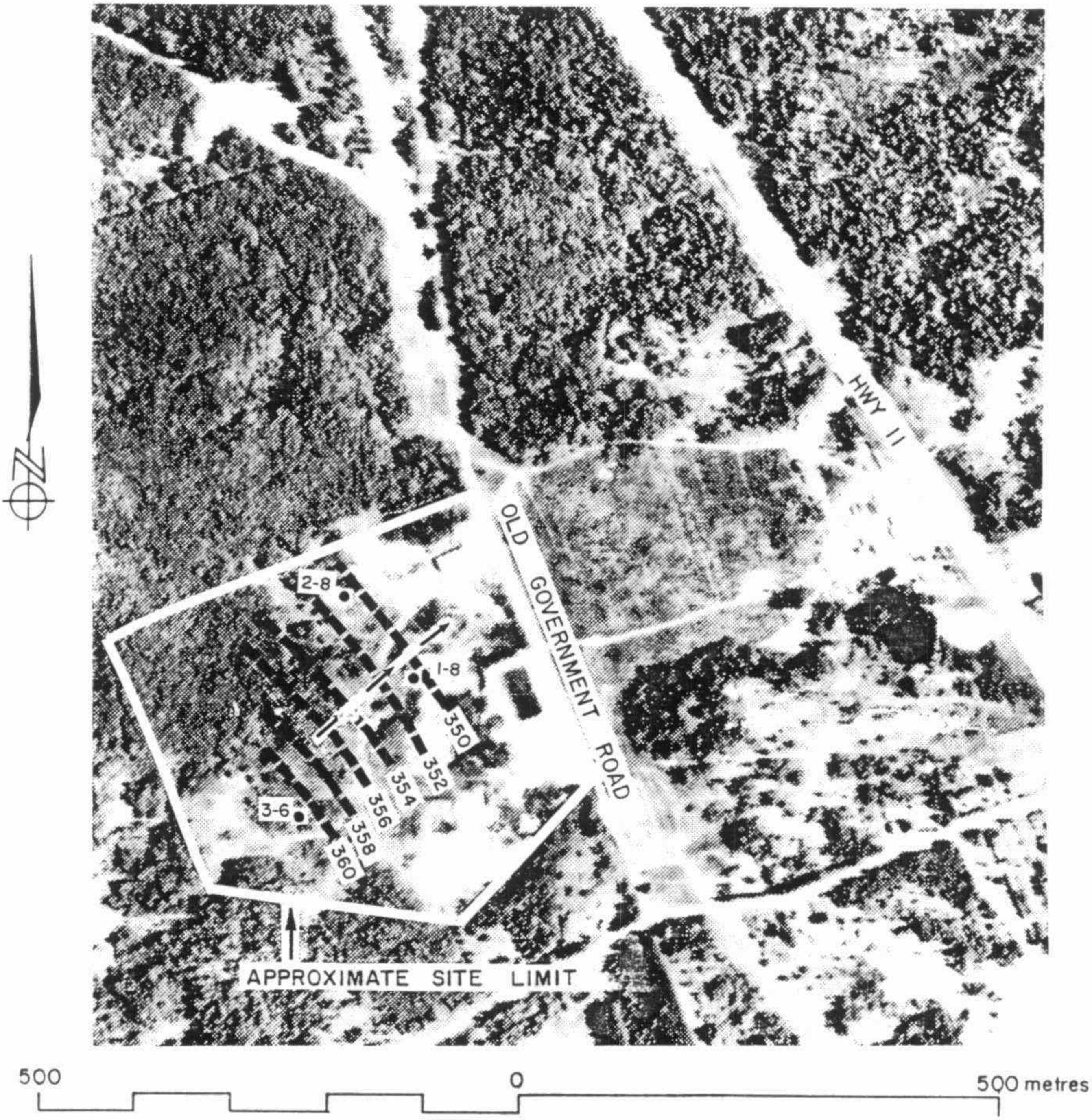
South of the site, a small intermittent creek was mapped. Throughout the field study, the creek was frozen; therefore, flow measurements and samples could not be taken. The creek flows eastward towards Emsdale where it merges with a larger tributary of the Magnetawan River.

Groundwater

Based on the results of our test drilling, a single water bearing formation was identified at the site. The unit consists of more than 12 m of silty sand to sand and gravel. The surficial sand unit is an unconfined aquifer and groundwater flow is generally eastward.

The water table surface is below ground surface. In excavated areas, the water table is at or near ground surface. The calculated hydraulic gradient across the site is about 0.05. Figure 8 shows the general direction of groundwater movement.

At three test drilling locations, deeper wells were also constructed. Water levels in these wells also indicate eastward groundwater flow. Figure 9 presents the potentiometric surface developed using water levels from the deep wells. The calculated hydraulic gradient for the potentiometric surface is about 0.03. This is similar to the water table gradient.



SCALE 1:6200

LEGEND

●	Well location and water level elevation
▬ ▬ ▬ 350	Potentiometric contour*
→ →	Groundwater flow direction

*(Elevations are based on an assumed elevation of 100m for the TBM converted to assumed geodetic elevation 351.9 m.a.s.l.)

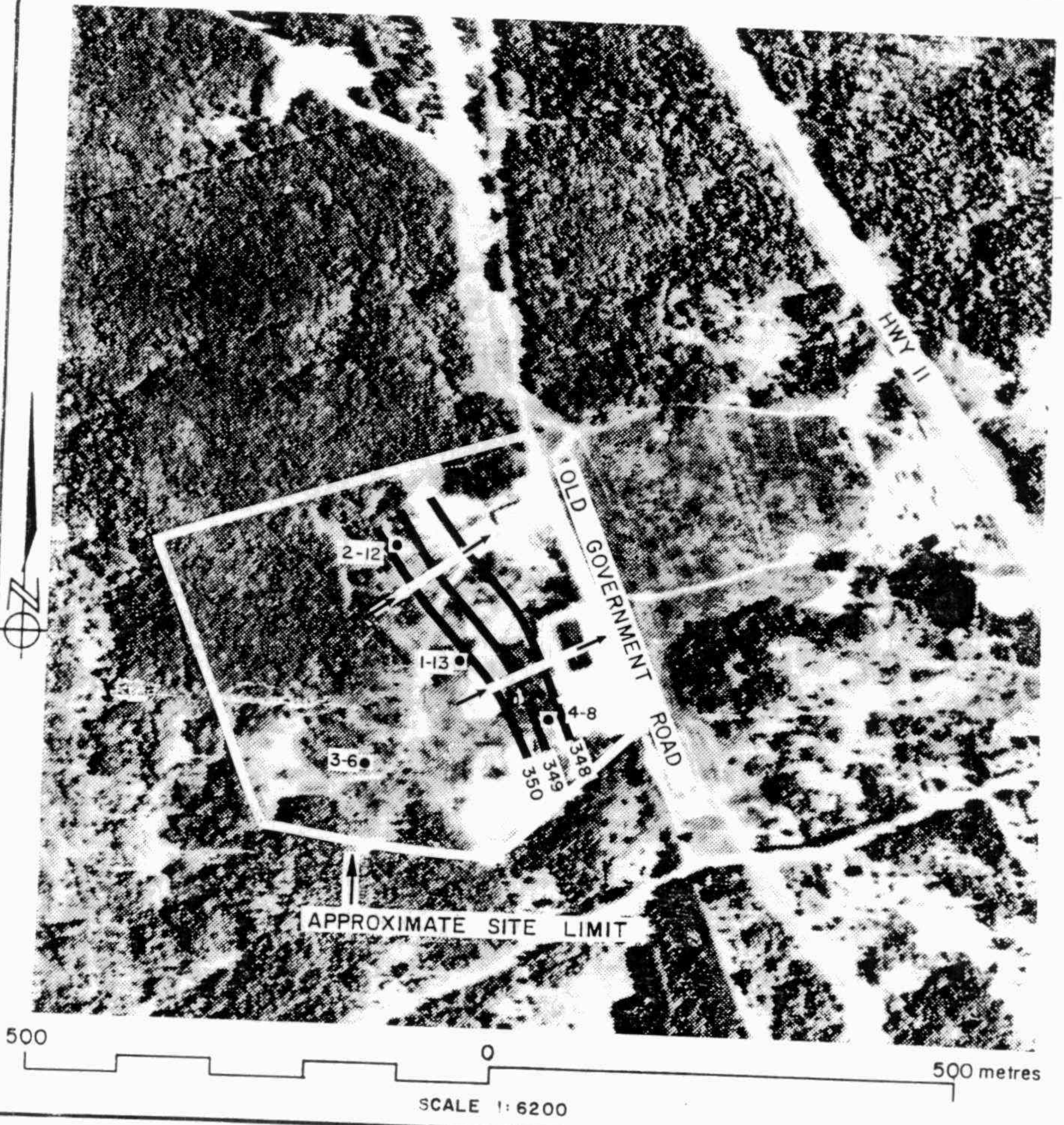
MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

WATER TABLE MAP

PROJECT No. 628-881

FEB., 1989

8



SCALE 1:6200

LEGEND

● Well location and water level elevation

▬ 350 Potentiometric contour

→ → Groundwater flow direction

*(Elevations are based on an assumed elevation of 100m for the TBM converted to assumed geodetic elevation 351.9 m.a.s.l.)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

POTENTIOMETRIC SURFACE

PROJECT No. 628-881

FEB., 1989

9

The average linear groundwater velocity can be estimated using the Darcy equation:

$$V = \frac{Ki}{n}$$

where V = average linear groundwater velocity
K = hydraulic conductivity
i = horizontal hydraulic gradient
n = effective porosity

Using a hydraulic gradient of 0.05, an average hydraulic conductivity of 5×10^{-4} cm/sec, and an assumed effective porosity of about 0.2, the average linear groundwater velocity is estimated at about 39 m/yr. Because of variations in formation K, the average linear groundwater velocity in the subsurface can vary by a factor of 10.

Assuming an average thickness for the aquifer of at least 15 m, and an overall cross-sectional width of at least 70 m, the estimated groundwater flow-through in the shallow aquifer beneath the site can be calculated as follows.

$$Q = KiA$$

$$\begin{aligned} &= 5 \times 10^{-6} \text{ m/s} \times .05 \times (15 \times 70) \text{ m}^2 \\ &= 2.6 \times 10^{-4} \text{ m}^3\text{/s} \\ &= 8200 \text{ m}^3\text{/year} \end{aligned}$$

At two locations, nests of wells were constructed. Downward hydraulic gradients were measured at both locations. At the OW 1 nest, the calculated vertical gradients ranged from 0.04 to 0.08 downward. At the OW 2 nest, the calculated gradient is about 0.12 downward.

In general, the vertical gradients are about the same magnitude as the horizontal hydraulic gradient. This shows the potential for groundwater movement, both vertically and laterally is about the same.

4.4 Groundwater Quality

Landfill Wells

Water quality samples were collected in January 1989 from each observation well on-site. Appendix G presents the detailed water quality results and Table 1 summarizes the observation well chemistry.

Because of adverse field conditions, field filtering of water samples for metals analysis could not be done. Since the samples for metals were collected in bottles containing preservatives, the metals results (Table G-1) represent a measure of the total metals.

Included in the metals scan are calcium, magnesium and sodium, some of the major cations used in the ion balance calculations (Table G-2). Because total metals were measured, the balance of cations and anions generally show greater than a 5% difference.

Typical indicators of landfill leachate such as chloride, sulphate, nitrogen (nitrate, ammonia and nitrite), pH and alkalinity were used to determine the effect of the landfill on local groundwater quality. Also, these parameters are used as a measure of leachate strength in wells located immediately downgradient from waste deposits.

In OW 1-13, the deepest well immediately downgradient from the derailment wastes, the levels of typical leachate indicators were not elevated. However, slightly elevated fluoride, chloride, phosphate and pH levels were noted in OW 1-5, the shallowest well in the nest. Although levels are well within the MoE Drinking Water Objectives (DWO), these parameters are above local background conditions. Table 1 presents a comparison of on-site groundwater quality and DWO.

pH levels within the study area range from 6.0 to 7.0. However, at OW 1-5, pH levels exceed 8.0, indicating contributions of alkaline groundwater to the flow system. The caustic derailment wastes placed in trenches immediately west of OW 1 are interpreted to be the source for the elevated pH's.

TABLE 1

WATER QUALITY SUMMARY

Parameter	MoE DWO	OW 1-5	OW 1-8	OW 1-13	OW 2-8	OW 2-12	OW 3-6	OW 4-8
Total Alkalinity	-	79	31	31	11	31	14	18
Chloride	250.0	7.6	0.9	1.0	0.4	1.2	0.4	0.41
Flouride	2.4	0.16	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate	500.0	18.5	10.2	13.6	7.0	18.3	6.4	10.2
pH (pH units)- lab	6.5-8.5	8.1	6.5	6.8	6.3	6.8	6.4	6.6
- field	-	7.1	6.0	6.0	6.0	6.0	6.0	6.0
Nitrate	10.0	0.47	0.56	0.98	0.18	0.16	0.11	0.22
Organic Nitrogen	0.15	0.19	0.06	0.01	0.10	0.13	0.07	0.03
DOC	-	3.0	0.7	0.6	0.6	1.0	0.9	0.2
Phenols	.002	<.0005	.001	<.0005	<.0005	<.0005	<.0005	<.0005
Field Specific Conductance (umho/cm)	-	190	80	90	100	35	40	55

Notes:
1. Concentrations in mg/L unless otherwise noted
2. Sampling date January 12, 1989
3. Analysis by Barringer Laboratories
4. MoE DWO - Ministry of the Environment Drinking Water Objective
5. OW 2-8 and OW 2-12 represent typical background groundwater quality.
6. Organic Nitrogen = TKN - Ammonia

One sample was collected from OW 1-5 for a complete organic scan. The organic water quality testing included volatile organics, acid extractables and PCB's. No organic contamination was detected in the testing. The results are presented in Appendix G.

At the OW 2 nest and at OW 4-8, no evidence of contamination was observed. Levels of typical leachate indicators are at or below DWO levels and the water quality is considered representative of background conditions.

Private Wells

As a result of previous complaints by local residents, several private wells have been sampled by the MoE. To date, these results demonstrate that the landfill has not affected local groundwater quality. Appendix B presents the MoE water quality results.

At the time of our house-to-house survey, MBL undertook limited private well water quality testing using field testing equipment. The water quality parameters tested included pH, conductivity and temperature. The testing was done to confirm local conditions and determine if signs of leachate contamination were present.

Based on the results of the MoE testing and the MBL house-to-house survey, it is concluded that local well water is not affected by the landfill. Specific conductance readings ranged from 42 to 350 umhos/cm and alkalinity is very low ranging from 17 to about 103 mg/L. Another typical indicator of caustic materials is pH. pH values ranged from a low of 5.9 to a high of 6.5. This is well within the range considered acceptable for human consumption.

The off-site and on-site field chemistry results were compared (Table 2) to evaluate the private well chemistry. The results from field testing at the private wells shows that the private wells have water quality typical of local background conditions. The only well showing elevated pH and alkalinity was OW 1-5, the shallow well immediately downgradient from the derailment waste area.

The specific conductance (conductivity) of this well is also marginally higher than other on-site wells but is within the range measured at the private wells. Since conductivity can also be influenced by other constituents, no specific conclusions can be made from these results.

TABLE 2

COMPARISON OF ON-SITE AND PRIVATE WELL WATER QUALITY

Well No.	Name	Conductivity (umho/cm)	pH	Alkalinity (mg/L)
6	Stoher	130	6.5	103
11	Fetterly	250	5.9	86
12	D. Marshall	90	5.9	34
13	Hughes	350	5.9	34
14	Gilpin	120	6.2	69
15	E. Marshall	42	6.2	17
16	Warehouse	107	6.2	51
17	Stanley	60	6.2	34
18	Powell	112	5.9	34
19	Nolan	150	6.2	103
OW 1-5	-	190	7.1	171
OW 1-8	-	80	6.0	52
OW 1-13	-	90	6.0	52
OW 2-8	-	100	6.0	52
OW 2-12	-	35	6.0	34
OW 3-6	-	40	6.0	34
OW 4-8	-	55	6.0	52

5.0 IMPACT ASSESSMENT

5.1 Groundwater Contamination

Leachate Generation

Leachate is generated when precipitation infiltrates into a decomposing waste and leaches out the organic and inorganic constituents. The leachate generated either runs off across impermeable ground surfaces or migrates downward through permeable soil to the water table.

At the Emsdale landfill, the waste is primarily buried above the water table. Therefore, groundwater flow-through does not contribute substantially to leachate generation. Leachate is generated as a result of water entering the refuse by direct infiltration of precipitation.

To estimate the volume of leachate being generated, the amount of infiltration and runoff must be calculated. One means of doing this is by estimating the hydrologic budget for the site. This can be done using the simplified water balance equation:

$$P = R + E + I + S$$

where: P = Precipitation
(the average annual precipitation recorded at Huntsville is about 971 mm/yr)

E = Evapotranspiration
(estimates for Southern Ontario watersheds range from 533 mm to 660 mm. The estimated E in the site vicinity is about 559 mm.)

S = change in groundwater storage
(net changes in groundwater storage are zero since long-term averages are used)

R = surface runoff

I = infiltration
(studies for Southern Ontario watersheds shows that infiltration or recharge to the groundwater system ranges from 40 to 45% of total precipitation in areas with glaciofluvial type sands at ground surface)

Resolving the equation for R by substituting the above values of P, I, S, and E gives

$$R = P - E - I - S$$
$$R = 82 \text{ mm/yr}$$

Since the site is sparsely covered with vegetation and the waste is buried below ground surface but above the water table, the runoff component of the hydrologic cycle will not contribute significantly to leachate production. Infiltration will be the main source of water for leachate production. The annual leachate production can be estimated using the water balance as follows.

$$\begin{aligned} LP &= I \times A \\ &= .330 \times 15200 \\ &= 5016 \text{ m}^3\text{/year} \end{aligned}$$

where: LP = Leachate production (m^3/year)
I = Infiltration (m/year)
A = Surface area of waste (m^2)

Leachate Quality

The landfill has been closed for some time; therefore, water infiltrating the waste has leached much of the soluble matter from the waste. Also, the waste burning reduced the amount of waste available for leachate production. The result is a very weak leachate.

The derailment wastes brought on-site in 1972 likely produce the strongest leachate at the site. Water quality from OW 1-5 represents the typical weak leachate from these wastes. Based on these results, the weak leachate produced can be identified by elevated pH, alkalinity, chloride and possibly some metals. However, test results show that contaminant levels are generally below MoE Drinking Water Objectives (DWO).

Leachate Attenuation

The on-site area downgradient from the waste but not containing refuse is about 2.5 ha. Infiltration from direct precipitation within this area is estimated at 8300 m^3/yr.

The calculated groundwater flow-through from upgradient areas (Section 4.3) provides an additional 8200 m^3/yr for leachate dilution. This gives a total dilution of at least 3 times the leachate being produced. Therefore, little future impact is expected from the low strength leachate being generated at the site.

At present, the effects from the landfill are limited to areas immediately downgradient of the waste pile. At the site boundary monitoring (OW 4-8) shows that groundwater quality is similar to background conditions (OW 2 nest). Therefore private water supply wells located further downgradient are likely not affected by the landfill.

Further evidence of the limited effects from the landfill is the quality of groundwater in wells downgradient from the site. To date, there have been no noted impacts directly attributable to the Emsdale landfill. Background groundwater quality and water quality from wells downgradient from the site is well within MoE Drinking Water Objectives. Wells located immediately downgradient from the wastes also show little change in quality.

Landfill Gases

Landfill gases are produced by the anaerobic decomposition of organic refuse in all landfills. Methane (CH_4) is the most common of these gases, normally comprising 40 to 60% of total gas generation. Methane is explosive at concentrations between 5 to 15% by volume in air.

During summer months, landfill gases generally vent to the atmosphere through soil cover; however, when the cover is frozen or saturated, the natural egress of the gases is prevented. As a result, positive pressures may develop within the landfill pushing the gas laterally beneath the confining layer.

At the Emsdale site, landfill gases could migrate away from source areas through the coarse granular deposits. The water table will form the lower boundary for gas movement. Monitoring of the boreholes during the initial stages of drilling (above the water table) did not find evidence of gas movement.

Although the site contains domestic waste there was a substantial amount of burning done before it was buried. Since little material capable of generating gas remains in the waste pile and because the refuse is covered with permeable soil, it is interpreted that there are, at best, only limit potential landfill gas hazards. These are restricted to areas immediately over the waste. Off-site movement of landfill gas is not current or a potential concern.

6.0 FUTURE WORK REQUIREMENTS

One of the study objectives is to determine the need for future work at the Emsdale landfill. This includes additional monitoring that may be needed or remedial actions to alleviate existing or future impacts.

At this time, existing site impacts are not significant. Therefore, work to remediate an existing problem is not needed. The Emsdale site has been closed for about 17 years. The site does not contain significant volumes of putrescible material. Therefore, leachate generation is limited. The potential for leachate generation will decrease significantly with time. At present, most of the soluble constituents have likely been leached from the waste.

Future impacts will likely be limited. The weaker strength leachate expected in the future will further reduce the potential for impact on local water resources. Therefore, contingency measures to deal with potential future problems are not needed at this time. Since the potential effects on local water resources are interpreted to be small, no further monitoring of surface water or groundwater is needed.

To ensure on-site safety, the derailment waste area should be clearly identified and secured with fencing. The east side of the area, in the gravel/sand pit, should be backfilled to ensure the pit wall is stable from either natural or man-induced slope failure.

7.0 CONCLUSIONS

Based on the results of the hydrogeologic study conducted at the Emsdale landfill the following conclusions can be made.

1. The landfill was operated as a trench and area fill site in worked out sand and gravel pits.

2. The sand and gravel at ground surface extends to a depth of at least 12 m. The granular deposit forms an unconfined aquifer that provides a local water supply source.

3. On-site testing shows the derailment wastes are not currently a significant contaminant source. Leachate from the waste has resulted in elevated alkalinity, pH and chloride in the shallow well immediately downgradient of the waste. The extent of leachate contamination does not appear to extend beyond the site boundary.

4. Leachate from the domestic refuse also has a limited effect on water quality. No off-site contamination originating from the domestic refuse was detected.

5. There are no on-site engineering works used to contain wastes except for the reported lining of the derailment waste trench. Some small amount of leachate appears to have escaped the lined trench; however, there is no significant effect on human health and safety or the physical environment.

6. Because of the waste types at the site, and the burning of wastes before burial, landfill gas generation is very limited. As a result, the migration of landfill gases will not be a hazard to buildings or structures located off-site.

8.0 RECOMMENDATIONS

Based on the hydrogeologic study and impact assessment at the Emsdale landfill the following recommendations are presented.

1. The engineering system used to contain the derailment wastes has been, at least in part, breached. This is resulting in a minor loading of contaminants to the local groundwater regime. Since the measured impact is not significant, the wastes should not be disturbed. The area around the waste pile (see Figure 5) should be clearly marked with signs/fences that identify the potential hazard.

2. The area at the east side of the waste pile in the adjacent sand/gravel pit should be stabilized against potential slope failures. This can be done by backfilling to original ground surface and maintaining a slope less than the natural angle of repose for the backfill. The existing cover on the derailment wastes should be reshaped to shed water.

3. Since there is no current or expected future degradation of groundwater quality at the site boundary and the derailment wastes are to be stabilized against future disturbances, there is no need to undertake additional groundwater or surface water monitoring.

Respectfully submitted,
MORRISON BEATTY LIMITED

Lee D. Howell, C.E.T.

David W. Sawicki, P.Eng.

Brian Beatty

Brian W. Beatty, P.Eng.

REGISTERED PROFESSIONAL ENGINEER
D. W. SAWICKI
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
B. W. BEATTY
PROVINCE OF ONTARIO

APPENDIX A

STUDY METHODS

APPENDIX A

STUDY METHODS

The study program was carried out in three general phases:

- Background review and site reconnaissance
- Site instrumentation and monitoring
- Data evaluation and report preparation

PHASE I:

BACKGROUND REVIEW AND SITE RECONNAISSANCE

Available geologic, hydrogeologic, and climatic data were compiled and reviewed to establish the regional physical setting. MoE water well records for the area were also reviewed. A local house-to-house well survey was conducted to establish local water uses as well and identify local aquifer characteristics. The background data review helped establish regional conditions and enabled the development of a water budget.

A site reconnaissance was done to evaluate on-site conditions, including the need for specialized health and safety equipment. During the site reconnaissance local topography, drainage, and land uses were mapped. Test drilling locations and surface water sampling stations were tentatively identified. Also, general site conditions were documented. Field observations were then consolidated with published information and discrepancies resolved.

HEALTH AND SAFETY

Because the derailment wastes are known to be corrosive, a formal approach to health and safety was needed. The focus of the program was hazard avoidance.

Common physical hazards associated with heavy equipment and field work at waste sites were fully addressed to ensure worker safety. Standard personal safety clothing such as hard hats, steel toe and shank boots, PVC or equivalent water resistant gloves, eye protection, and chemically resistant PVC splashsuits were utilized. Appropriate cartridge type respirators were available for use during the drilling phase. The respirators were not needed.

Personal hygiene was stressed with particular emphasis on hand to mouth contact to avoid contaminant ingestion. Soap, towels and wash basins for decontamination were available on-site. Potable water was available as wash water and as drinking water.

First aid supplies and equipment including a portable eye wash bottle were at the drill site at all times. At least one worker present at the site held a current St. Johns Ambulance First Aid Certificate.

The program was supervised by the on-site MBL representative who acted as safety officer.

PHASE II:

SITE INSTRUMENTATION AND MONITORING

Test Drilling

Seven boreholes were drilled at four separate locations across the property. The boreholes ranged in depth from 4.5 to 12.3 m below ground level. Drilling was completed using a track mounted Nodwell with a Mobile B-57 drill rig operated by Environmental Monitor Ltd. of Ingersol, Ontario. Due to the granular nature of the overburden and the numerous large boulders, it was necessary to mud rotary the boreholes. At 1.5 m intervals or noted changes in stratigraphy representative soil samples were collected using a 50 mm diameter split spoon.

The soil samples were examined and described in the field. Subsequently, detailed descriptions of the stratigraphy were developed and representative soil samples were selected for laboratory testing.

At selected locations observation wells were nested to establish vertical gradients and evaluate the vertical groundwater quality profile. Where nests were constructed, only the deepest hole was sampled in detail. In the shallower wells, a splitspoon sample was collected to confirm stratigraphy at the screened depth only. The borehole logs and well completion details are presented in Appendix D.

Instrumentation

In each borehole a 50 mm diameter PVC observation well was constructed. Each well consists of a 1.5 m long #10 precision slotted well screen with a 50 mm flush threaded PVC casing that extends above ground surface.

The well screens are surrounded with a coarse sand filter pack. The filter in each well was extended above the slotted interval and a bentonite seal was installed above the sand pack. Sandy native soils were used to backfill the remaining annulus to a depth of 1.5 m below ground level. A second bentonite seal was installed and a lockable steel protective casing was grouted in place. The observation wells were labelled with an identification number (eg., OW 1-5). The first number refers to the well nest location. The second number is the well depth below ground level to the nearest metre. The well construction details are presented on the borehole logs in Appendix D.

Upon completion of the wells, relative elevations were established for both measuring points and ground surface at each location. All elevations are relative to an assumed 100.00 m temporary benchmark located at the southwest corner of the Perry Township garage.

Gas Probe Construction

Landfill gas monitoring was undertaken during observation well drilling. While drilling above the water table at each location a Bacharach Model H combustible gas indicator was used to monitor the concentration of combustible gases (methane). These data were used as part of the on-going evaluation of risks for worker health and safety and to determine the need for landfill gas probe construction at each location.

No evidence of landfill gases were observed during the test drilling. Considering the drilling locations, the remote site location, the waste type and methods of site operation, gas probes were not constructed.

Field Monitoring and Sampling

After construction, each monitoring well was developed to remove drilling fluids and fines introduced into the well during drilling. Development was completed by hand bailing. The development ensures the observation wells are functioning adequately and improves the reliability of water quality samples.

Baildown/recovery testing was conducted on each well to determine the formation hydraulic conductivity. Using the basic time lag method developed by Hvorslev (1951), representative hydraulic conductivities were calculated. Test results were compared to values anticipated from field observations and grain size distribution curves to ensure no major discrepancies. Table F-1 presents the calculated hydraulic conductivities and Appendix F describes the methods used.

Water Level Monitoring

Water levels in each observation well were monitored after drilling was completed and during the January 1989 monitoring. Before preparing the wells for water quality sampling, the water level in each well was measured and recorded. Table F-2 in Appendix F presents a summary of measured water levels.

Groundwater Sampling

To ensure that representative groundwater samples were collected, at least three casing volumes of water were removed from each well before sampling. Each well was allowed to recover to near static condition before sampling. Between wells, the bailer was thoroughly washed using laboratory-grade detergent, then rinsed with dilute hydrochloric acid followed by a tap water rinse and a distilled water rinse. The initial bailer of water from each well was used to rinse the bailer thoroughly and to rinse each sample bottle not containing preservatives.

After collection, each sample was stored at a temperature of about 4° C and submitted to Technical Service Laboratories in Mississauga for analysis. The water quality results are presented in Appendix G.

Surface Water Sampling

Since no significant surface water courses were mapped on site, no samples were collected.

PRIVATE WELL SURVEY

A private well field sampling program was completed as part of the house-to-house survey. A total of 10 private wells were surveyed. During the interview with the well owner, information about the well was collected. Also, a sample of untreated tap water was analyzed for conductivity, temperature, pH and alkalinity. Testing apparatus included: a Beckman Bridge Conductivity Meter for temperature and conductivity; wide range litmus papers for pH; and, a portable Hach Kit for alkalinity measurements. Results are usually within about 5% of measured laboratory values. The private well test results are presented on Table G-3, Appendix G and the private well survey is summarized in Appendix C.

PHASE III:

Date Evaluation

The results of the Phase I and Phase II programs were compiled and evaluated. The results are described in the text of this report. The collected data are presented in Appendices B through G.

APPENDIX B

MoE BACKGROUND DATA

- Background Correspondence
- Background Water Quality

ONTARIO

DEPARTMENT OF THE ENVIRONMENT

(705) 474-5643

File No. B 6850

Waste Management Branch,
649 Cassells Street,
NORTH BAY, Ontario.

March 28, 1972.

A/F
pls follow up / S.
10/4

Mr. A. Roske, P. Eng.,
Canadian National Railways,
CAPREOL, Ontario.

Dear Mr. Roske:

This letter will acknowledge disposal procedures arranged for the railway spillage occurring from the derailment at Mileage 155.0 New Market subdivision. It is the understanding of this Branch, that the following substances were spilled:

(1) Borax

(2) Iron Pyrite

(3) Caustic Soda

(4) Soda Ash

(5) Kwik-seal

(6) Speareseine

(7) Magcobar

The site was visited by the writer and Mr. Cathcart of this Branch, on Friday, March 24, 1971. At that time, contact was made with Mr. S. Bucyk, Road Master, with respect to proposed disposal methods for the above materials.

It was agreed disposal would take place at the Township of Perry waste disposal site located lot 13, concession 11, (Emsdale). This site is certified under provisional

......2

certificate of approval number 522502. The area was visited, and an agreed upon area is to have two excavated. The first trench is to be lined wit sturdy strong plastic liner. This liner is to n an application of approximately 6" of fill material previous to the deposition of waste material. This trench is to be used exclusively for caustic soda. When the material has been placed in the trench, back-filling shall occur with mechanical equipment used to compact the fill. The second trench will be used without special precaution for disposal of all other materials. This trench also shall be back-filled and compacted with mechanical equipment.

A sketch of the property is to be provided to this office by Canadian National Railways, indicating the exact location and depth of each trench. The operation for disposal, is to be supervised by Mr. I. Giaschi of the Private Waste and Water Management Branch, Bracebridge. Mr. Bucyk is to contact Mr. Giaschi previous to disposal, and is to dispose of the materials resulting from the spill under Mr. Giaschi's direction.

Please advise this office in writing when the complete clean-up has been accomplished.

Yours very truly,

J. E. Farrar (Miss)

per- W. F. Wells, P. Eng.,
Regional Engineer,
Northern Ontario.

WFW/jef
cc: Mr. Riness, Clerk-Treasurer,
Township of Perry

Mr. W. Crawford, Chief Inspector,
Muskoka-Parry Sound Health Unit.

Canadian National Railways
Northern Ontario Area

CAPREOL, Ontario
19th April 1972

Our File 1020-28

Mr. W. F. Wells, P. Eng.
Regional Engineer
Northern Ontario
Waste Management Branch
Department of the Environment
649 Cassells Street
NORTH BAY, Ontario

Dear Sir Re: Derailment at Novar on March 20th at Mile 155.2
Newmarket Subdivision

With reference to your letter of March 28th concerning disposal of certain spilled substances at the above derailment.

Under the direction of Mr. L. Giaschi of Waste Management Branch and supervision of our Roadmaster S. Dewcyk, all spilled chemicals and other waste materials were loaded into trucks and delivered to the designated disposal locations at Emsdale.

Trenches were excavated and waste materials were buried at the site in the presence of Mr. Giaschi, and to his satisfaction. The complete clean-up at the derailment site has now been completed.

Thanking you for your assistance and co-operation in this matter.

Yours truly

A. I. Fitzpatrick
Engineer Maintenance

AIF/jm

MANAGEMENT BRANCH
RECEIVED
APR 21 1972
NORTH BAY
NORTHERN REGION

W.F.W.
8/6/72.

ONTARIO

DEPARTMENT OF THE ENVIRONMENT

ENT BRANCH
RECEIVED
SEP 5 1972
NORTH BAY
NORTHERN REGION

AUGUST 31, 1972

A5225

ORANDUM:

FILE

: ERIC CLIPSHAM

ct: PERRY TOWNSHIP DUMP S.

AUGUST 2, 1972 - Received phone call from Duncan Marshall RE; Dump polluting his water supply.

AUGUST 8, 1972 - Took water samples in pond at rear of Marshall's house, and in pond at rear of Griffith's house (upstream).

	Total	Faecal
MARSHALL	80 +	54
GRIFFITHS	80 +	80 +

AUGUST 8, 1972 - Checked septic systems upstream from Duncan Marshall.

- Found Griffith's installing new S.T.S. - septic tank, draining onto ground - advised owner to pump out tank and lay new tiles.
- Found Mr. Rand (further upstream) with wash wastes draining into cesspool in yard.

AUGUST 9, 1972 - Took water sample at pond in yard of Mr. Rand.

Total	Faecal
2800	2100

Advised Mr. Rand to install a proper septic system.

This paper contains recycled Canadian waste

AUGUST 17, 1972 - Inspected test-holes at new township dump site (proposed) in company of Reeve Gord Mason, Duncan Marshall, and Adrian Labelle.

- Soil profile showed 4 - 5 ft. of dry sand, below which there appeared to be 4 - 5 ft. of clay and/or gravel.

Watertable appeared in test holes at low, northeast area of field.

Marshall appeared satisfied with new Dump site.

AUGUST 18, 1972 - Took water sample of Duncan Marshall's drinking water from tap at kitchen sink. Also took sample at outlet of underground stream adjacent to dumpsite.

	Total	Faecal
MARSHALL	0	0
STREAM	4	0

AUGUST 25, 1972 Visited dump in company of Mr. Cathcart, Mr. Mason, and Mr. Ellsmere.

- Proposed dumpsite appeared to be satisfactory.

Eric Clipsham

EC/bhc

Eric Clipsham,
Technician.

ONTARIO

DEPARTMENT OF THE ENVIRONMENT

ate: October 11, 1972.

EMORANDUM: File No. A 5225 02

o: Mr. W. F. Wells, P. Eng.,
Regional Engineer, Northern Ontario.

rom: Mr. D. J. Cathcart, Asst. Reg. Engineer,
Northern Ontario.

ubject: Perry Township - Approval in Principle

On August 25th, 1972, the writer and Reeve G. Mason inspected an area on lot 13, concession 11 which is proposed as a waste disposal site to replace one already operated on that lot. At present the land is privately owned but is available for sale to the Township.

The area is an old farm field of about 7 - 8 acres, which has grown wild for the past few years. Numerous test-holes which had been dug to a depth of about 7 feet, showed the soil to be a homogeneous mixture of coarse sand with a small proportion of silt for the full depth of each hole, except the lowest one in the north-east corner. In that particular hole a stiff impermeable clay was found at a depth of 5 feet and the hole contained about one foot of water. Because of the previous rainfall it was impossible to judge if this water resulted from a perched watertable on top of the clay or merely from surface run-off.

According to the Private Waste and Water Management Branch, Huntsville, which has done some test borings in the area, a clay belt, about 2 feet thick, runs through the area. Below this is a large depth of sand and gravel.

The eastern edge of the field borders on a township road. It is intended to fence off this side of the field so that access to the proposed dumping area can only be gained by the gated entrance to the present site.

It is felt that a 'trench operation' in this field would fulfil the waste disposal needs of this area for many years. However, without further investigation of the soils and hydrology of the north-east corner it is impossible to judge how satisfactory this particular portion is for waste disposal.

It is therefore recommended that approval in principle be given to the Township of Perry for the proposed alteration of their waste disposal practices on lot 13, concession 11, on the following conditions:

(1) Wastes shall be deposited in trenches, the bottom of which shall be at least 3 feet above maximum watertable, or any perched watertable which may be encountered.

Aproval in Principle sent. 20/3/73.

This paper contains recycled Canadian waste

(2) No wastes shall be deposited in the north-east quarter of the field without further investigation of the hydrology of that area and the written permission of the Waste Management Branch.

This site is intended to serve approximately 500 people (half the municipality) and, although the existing site has given rise to some complaint, it is felt that there is not sufficient reason to refer this matter to the Hearing Board.

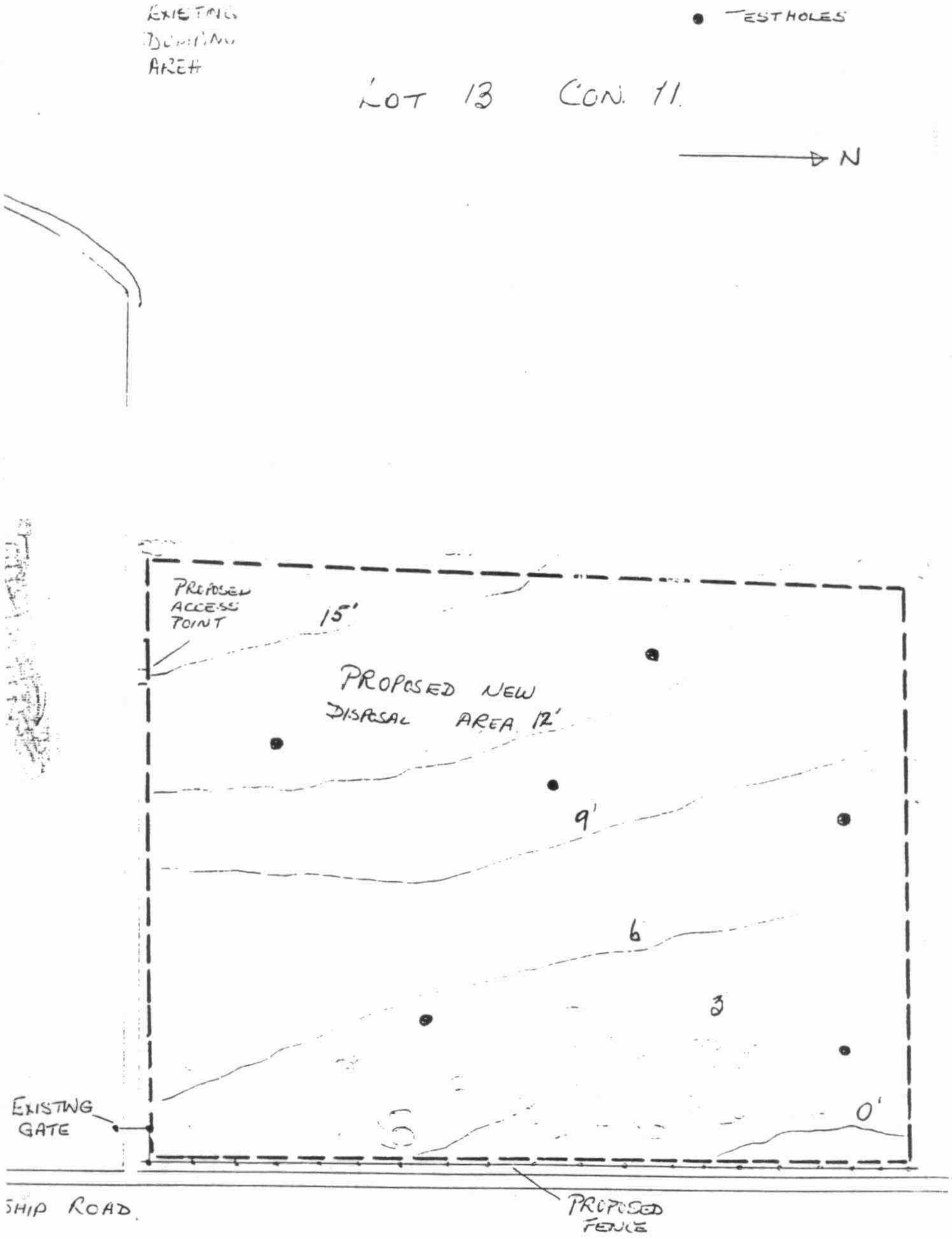
D. J. Cathcart

D. J. Cathcart

DJC/jef

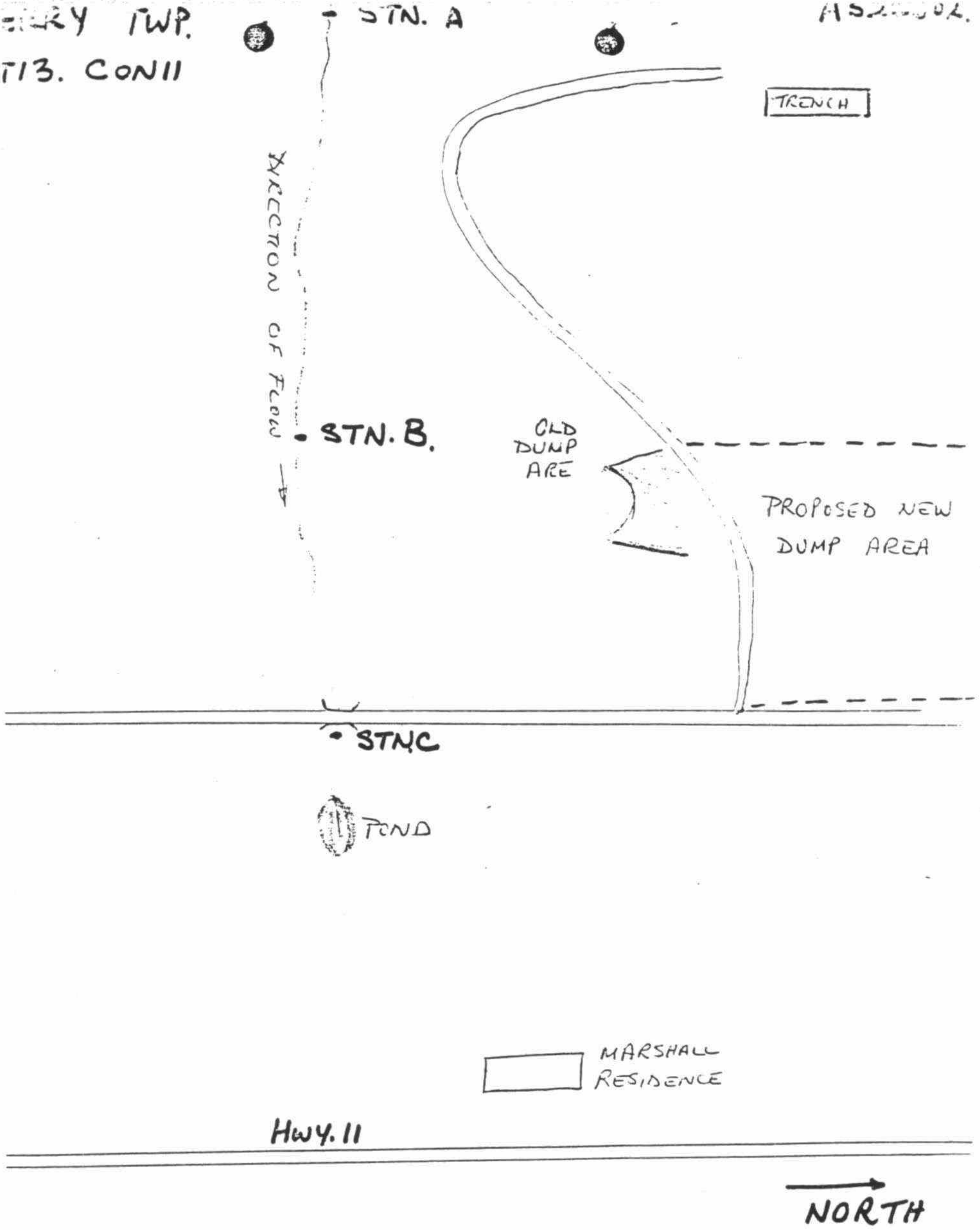
TWP. OF PERRY 45225

LOT 13 CON. 11



…RY TWP.
T13. CON II

AS[illegible]0Z.



W.F.W.

January 31, 1980

Mr. Wayne Downing,
R.R. # 1,
EMSDALE, Ontario
P0A 1J0

Dear Sir:

Re; Unknown Solid Waste At Emsdale Dump

A powder speck of the unknown solid waste uncovered at the Emsdale dump site was analysed. Of the metals sampled for, it was found to contain the following:

Copper	100	ug/l	(parts	per	billion)
Cadmium	40	ug/l	"	"	"
Lead	470	ug/l	"	"	"
Nickel	25	ug/l	"	"	"
Zinc	90	ug/l	"	"	"
Arsenic	24	ug/l	"	"	"
Selanium	.06	ug/l	"	"	"

It would not be uncommon to find any of these metals at any dump site.

The main concern would be to ensure that leachate leaving the dump area does not contaminate any surface water or ground water supplies.

Often leachates may be treated by attenuation through the water and soils through which they pass or through nutrient uptake by vegetation. The three major processes are: biological decomposition, dilution and chemical processes. In the three processes the distance between the source of the contaminate and source that must be protected is a major factor. This distance varies with many factors. We suggested to the Municipality that monitoring wells be placed to monitor the effects of any leachate leaving the site. By monitoring the movement of the leachate and its effect on the surrounding ground water it would allow the Municipality to take steps to ensure that interference with surrounding water supplies does not occur.

The substance uncovered at the dump would be a contaminant, but no more of a contaminant than any other refuse disposed of at the site.

Should you have any questions please contact me.

Yours very truly,

Harvey Nel
Environmental Officer

HN:mv

MP-13-02
A-522502

February 26, 1980

Mr. Wayne Downing,
R.R. #1,
EMSDALE, Ontario.
P0A 1J0

Dear Mr. Downing:

Re: Unknown Solid Waste at
Emsdale Dump

Further to my letter dated January 31, 1980, I have been in contact with the Canadian National Railway and provide the following information concerning the waste disposed of at the Emsdale Dump as the result of the train derailment. The derailment occurred in 1972 and the disposal of the waste took place under the supervision of our Waste Management Branch.

The following substances were spilled:

(1) Borax

(2) Iron Pyrite

(3) Caustic Soda

(4) Soda Ash

(5) Kwik-seal

(6) Speareseine

(7) Magcobar

With the exception of the Caustic Soda, all other wastes were disposed of in an open trench and backfilled as they were considered non toxic. Caustic Soda, however, is toxic and corrosive and was buried in a plastic lined trench for this reason. From the description of the corrosive nature of the material uncovered, I would suspect that it is the Caustic Soda.

Wells located south of the disposal area were sampled and if there was any connection between these wells and the Caustic Soda disposal area, it would be indicated by elevated sodium levels in the wells. The analysis of the well water in these wells indicated abnormally low levels of sodium indicating no connection between the wells and the disposal area.

If this waste is still exposed we recommend that it be backfilled. Care should be taken to avoid skin contact with the Caustic Soda since it is a toxic material.

I trust you will bring this to the attention of Council.

Should you have any additional questions please contact me.

Yours truly,

Harvey Nelson,
Environmental Officer

HN/lr

bcc: R. Banach

MP -13-02 - A-522502 Perry Twp.

July 15, 1986

Township of Perry
P. O. Box 70
Emsdale, Ontario
P0A 1J0

Attention: Mr. Dave Maki
Clerk-Treasurer

Dear Sir:

Re: Closed Dump Site A 522 502
- Old Government Road
Lot 13, Concession 11
Township of Perry

This is further to my conversation with you on July 8, 1986 concerning the above waste disposal site.

Upon reviewing the files, the following substances were spilled by Canadian National Railway in the area of Novar and disposed of at your waste disposal site.

1. Borax
2. Iron Pyrites
3. Caustic Soda
4. Soda Ash
5. Kwik-Seal
6. Speareseine
7. Mangcobar

I trust this information is beneficial to you.

Yours truly,

Peter Lee
Environmental Officer

PL:sp

File MP 13-02

JIM

DEPT DATE

P. LEE MAR 31/87

DERRY TWP CLOSED DUMP - GOV'T ROAD

C.N.R. TRAIN DERAILMENT (A 522502 / LOT 13, CON II)

TRAIN DERAILMENT 1972 IN MOFFAT RESULTED IN THE DISPOSAL OF THE FOLLOWING IN THE ABOVE DUMPSITE

① BORAX
② IRON PYRITE
③ CAUSTIC SODA
④ SODA ASH
⑤ KWIK-SEAL
⑥ SPERSENE
⑦ MAGCOBAR

CAUSTIC SODA WAS THE ONLY SIGNIFICANT AMOUNT DISPOSED. IT WAS DUMPED IN TRENCHES LINED WITH PLASTIC.

WITH HILLIER ASSISTANCE WE HAVE SAMPLED THE WELLS IN THE AREA.

REPLY FROM REPLY DATE

DEPT DATE

T WAS FOUND THAT THE WATER IN
HESE WELLS WERE AGGRESSIVE. WE
DID NOT FEEL IT WAS CONTRIBUTED
ROM THE SPILL RATHER IT OCCURRED
NATURALLY. THIS IS BASED ON THE
LACK OF SODIUM IN THE H_2O SUPPLY
THE TWP OFFICE EXPLAINED THAT
HEY ARE STILL VERY CONCERNED.
BOUT 8 YRS AGO DURING A CRUSH-
G OPERATION AT THE CLOSED DUMP
SOME OF THE CAUSTIC SODA WAS
CIDENTALLY EXPOSED. SUPPOSIVELY
HIS SUBSTANCE BURNT THE BOTTOMS
F ONE OF THE WORKERS BOOTS.
BECAUSE OF THE TWP'S CONCERN &
OOD PUBLIC RELATIONS I WOULD
GREE WE SHOULD RE-SAMPLE AGAIN.

REPLY FROM REPLY DATE

TE: HANDWRITE

ND TO

ROM DEPT DATE

BJECT

– C.M.R. HAS WASHED THEIR HANDS OF THE INCIDENT SAYING M.O.E. PPROVED OF THE DISPOSAL AT THE SITE. THE TWP WOULD LIKE TO HAVE IT REMOVED.

LY

REPLY FROM

REPLY DATE

Background MoE Water Quality

Municipality: Township of Perry
Dist. of Parry Sound
Watercourse: Creek near the Emsdale Municipal Waste Disposal Site
Date Sampled: Aug. 4/72 by: W. Wells

Report to: Waste Management Branch
Ministry of the Environment
649 Cassells St.
North Bay, Ont.

c.c. central Files

Lab. No.	Sample Point No.	5-Day B.O.D.	Solids Total	Solids Susp.	Solids Diss.	Turbidity Units	Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	Chloride as Cl	pH at Lab.
R32-509							46	18	1.8	1	6.7
R32-510							32	20 ~~20~~	0.95	2	7.0

R32-509	1.	Creek on Lot 14, Con. 11, Perry Twp. - raw water
R32-510	2.	Freshwater pond on Lot 14, Con. 11, Perry Twp. - on afternoon of 4th Aug., 1972 - Raw water

ws fw
21/11/72

WASTE MANAGEMENT BRANCH
RECEIVED
AUG 22 1972
NORTH BAY
NORTHERN REGION

Municipality: Perry Twp.

Report to: D.J. Cathcart, Waste Management Branch,
649 Cassels St., North Bay, Ont.

c.c. central Files

Watercourse: Creek, Lot 13, Con II, Perry Twp.

Date Sampled: Aug. 25/72 by: D.J.C.

mm

Lab. No.	Sample Point No.	5-Day B.O.D.	Solids			Turbidity Units	Alkalinity as $CaCO_3$	pH at Lab	Nitrate as N	Total Phosphorus as P	Iron as Fe	Zinc as Zn
			Total	Susp.	Diss.							
R35-57		0.8		30			18	6.8	< .01	.048	1.1	<0.01
R35-58		1.0		10			15	7.0	.05	.018	0.50	<0.01
R35-59		1.0		0			17	6.9	.01	.060	1.3	<0.01

R35-57	1	Lot 13, Con II, Perry Twp. Creek
R35-58	3	" " " "
R35-59	5	" " " "

WASTE MANAGEMENT BRANCH
RECEIVED
OCT 10 197
NORTH BAY
NORTHERN REGION

W.F.W.

12-063

Ontario

Municipality: Perry Township
Source: Drilled well
Program: 22251
Date sampled: Sept 1979 by: L. Robertson
Date analysed: OCT 0 1 1979 Date reported:

Report to: Ministry of Environment Tel: 476-1001
Address: 1500 Fisher St.
North Bay
Attn: Lynn Robertson

C	✓
Bi	
Ba	

LAB. NUMBER	SENDER'S NUMBER	SAMPLING POINT LOCATIONS AND TIME	NATURE OF SAMPLE, DANGEROUS CONSTITUENTS, PRESERVATIVES USED, COMPOSITING DATA, ETC.	✓CHECK BELOW IF CHLORINE PRESENT
w38-37	1	Mrs Griffiths → Drilled Well - after [illegible] minutes		
38	2	Mrs Griffiths → Drilled Well [illegible] 10 minutes		

SEE DIRECTIONS OVER

no preservative added

M.O.E.
NORTHEASTERN
OCT 4 1979
RECEIVED
NORTH BAY

LAB. NUMBER	Nitrate	TOTAL PHOSPHORUS AS P	IRON AS Fe	ALKALINITY AS CaCO3	PH	SODIUM AS NA	MAGNESIUM AS Mg	CONDUCTIVITY µmho/cm			
w39-37	0.7	.04	.11	8	6.6	4.	1	92			
38	0.7	.02	.11	8	6.1	4.	<1	90			

FOR LAB USE ONLY

Sample Class: M Results

Metals in Water ITC

Inquiries at: Prem Vijan / Pat Lachmaniuk 235-6004
Telephone: 416-235-5834

Field Sample	Sampling Location	Sampling Location Description Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
Y-2	CODE NOT GIVEN	HARVEYS AUTO PERRY FROM TAP GLASS PLASTIC BOTTLE CLEAR	M03-0182		13/01/87		5
Y-3	CODE NOT GIVEN	CORMACK LOT 23 C5 PERRY FROM TAP CLEAR NOT GIVEN	M03-0183		13/01/87		5
Y-4	CODE NOT GIVEN	ALMAGON LODGE PERRY FROM TAP CLEAR NOT GIVEN	M03-0184		13/01/87		5
Y-5	CODE NOT GIVEN	GLAVES L22 C5 PERRY FROM POND CLEAR NOT GIVEN	M03-0185		13/01/87		5
Y-6	CODE NOT GIVEN	RINESS S OF DUMP PERRY FROM TAP CLEAR NOT GIVEN	M03-0186		13/01/87		5
Y-7	CODE NOT GIVEN	TEST PIT 1 PERRY LOW AREA OF DUMP CLEAR NOT GIVEN	M03-0187		13/01/87		5

Field Sample Number... Test Description Code, Units of Measure Method	Y-2 M03-0182	Y-3 M03-0183	Y-4 M03-0184	Y-5 M03-0185	Y-6 M03-0186	Y-7 M03-0187
IRON, UNF.TOTAL FEUT ,MG/L as Fe (Iron) 522AE2	1.500	.081	.094	.094	.029	.058
MANGANESE, UNF.TOTAL MNUT ,MG/L as Mn Manganese 522AE2	.026	.004	.008	.034	.008	.056
ALUMINUM, UNF.TOTAL ALUT ,MG/L as Al (Aluminum) 522AE2	<.004<	.005	.004	.028	.150	.057
CADMIUM, UNF.TOTAL CDUT ,MG/L as Cd (Cadmium) 522AE2	<.0003<	<.0003<	<.0003<	.0010	0003<	.0010
CHROMIUM, UNF.TOTAL CRUT ,MG/L as Cr (Chromium) 522AE2	<.001<	<.001<	<.001<	<.001<	001<	.016
COPPER, UNF.TOTAL CUUT ,MG/L as Cu (Copper) 522AE2	.001	.340	.019	.130	.042	1.000
NICKEL, UNF.TOTAL NIUT ,MG/L as Ni (Nickel) 522AE2	<.002<	<.002<	<.002<	<.002<	<.002<	<.002<
LEAD, UNF.TOTAL PBUT ,MG/L as Pb (Lead) 522AE2	<.003<	<.003<	<.003<	.003	<.003<	.054
ZINC, UNF.TOTAL	.004	.770	.057	.280	.033	.590

Environment Ontario NE37346 PERRY TOWNSHIP Page 5
FINAL REPORT Printed 23/02/87

Sample Class: M Results

Metals in Water ITC

Inquiries at: Prem Vijan / Pat Lachmaniuk 235-6004
Telephone: 416-235-5834

Field Sample	Sampling Location	Sampling Location Description Sample Description	LAB Sample#	Remarks	Sampling Date	Sampling Time	Zone
Y-8	CODE NOT GIVEN	TEST PIT 2 DUMP RD AT HWY 592 CLEAR NOT GIVEN	M03-0188		13/01/87		5
Y-9	CODE NOT GIVEN	L21 C5 POND FR POND SOME SEDIMENT FROM POND SOME SEDIMENT	M03-0189		13/01/87		5

Field Sample Number... Test Description Code, Units of Measure Method	Y-8 M03-0188	Y-9 M03-0189
IRON, UNF TOTAL FEUT ,MG/L as Fe (Iron) 522AE2	.095	.160
MANGANESE, UNF TOTAL MNUT ,MG/L as Mn Manganese 522AE2	.048	.001
ALUMINUM, UNF TOTAL ALUT ,MG/L as Al (Aluminum) 522AE2	.082	.014
CADMIUM, UNF TOTAL CDUT ,MG/L as Cd (Cadmium) 522AE2	.0010	<.0003<
CHROMIUM, UNF TOTAL CRUT ,MG/L as Cr (Chromium) 522AE2	.012	<.001<
COPPER, UNF TOTAL CUUT ,MG/L as Cu (Copper) 522AE2	.970	.120
NICKEL, UNF TOTAL NIUT ,MG/L as Ni (Nickel) 522AE2	<.002<	<.002<
LEAD, UNF TOTAL PBUT ,MG/L as Pb (Lead) 522AE2	.130	<.003<
ZINC, UNF TOTAL	.590	.120

Sample Class: W

Results

WATER (GRND/DOMESTIC) WQ
(Textual information after numerical data)

Inquiries at: JENIFER McBRIDE
Telephone: 416-235-5875

Field Sample	Sampling Location	Sampling Location Description Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
Y-2	CODE NOT GIVEN	HARVEYS AUTO PERRY FROM TAP GLASS PLASTIC BOTTLE CLEAR	W03-0071		13/01/87		5
Y-3	CODE NOT GIVEN	CORMACK LOT 23 C5 PERRY FROM TAP CLEAR NOT GIVEN	W03-0072		13/01/87		5
Y-4	CODE NOT GIVEN	ALMAGON LODGE PERRY FROM TAP CLEAR NOT GIVEN	W03-0073		13/01/87		5
Y-5	CODE NOT GIVEN	GLAVES L22 C5 PERRY FROM POND CLEAR NOT GIVEN	W03-0074		13/01/87		5
Y-6	CODE NOT GIVEN	RINESS S OF DUMP PERRY FROM TAP CLEAR NOT GIVEN	W03-0075		13/01/87		5
Y-7	CODE NOT GIVEN	TEST PIT 1 PERRY LOW AREA OF DUMP CLEAR NOT GIVEN	W03-0076		13/01/87		5

Field Sample Number...	Y-2	Y-3	Y-4	Y-5	Y-6	Y-7
Test Description Code, Units of Measure Method	W03-0071	W03-0072	W03-0073	W03-0074	W03-0075	W03-0076
CONDUCTIVITY 25C COND25,UMHO/CM at 25 D.CENT. 002BI2	85.8	70.3	72.8	13.0RRV	57.6RRV	153.0
HARDNESS, TOTAL HARDT ,MG/L as CACO3 CALC01	33.5	24.5	25.0	2.0<T	13.5RRV	64.5
SODIUM, UNF.REACT. NAUR ,MG/L as Na (Sodium) 002BA1	2.5	2.6	2.5	.3<T	1.3	2.9
POTASSIUM, UNF.REACT. KKUR ,MG/L as K (Potassium) 002BA1	1.90	1.23	1.08	.36RRV	2.00RRV	1.20
ALKALINITY,TOTAL ALKT ,MG/L as CACO3 004AT6	28.7	23.4	22.3	2.5	9.1	60.6
PH (-LOG(H+(CONCN))) PH ,DIMENSIONLESS 003AI2	7.37	7.22	7.21	6.10	6.48	7.90
CHLORIDE, UNF.REACTIVE CLIDUR,MG/L as Cl- Chloride 004AC1	1.25	2.10	3.30	.65	.75	4.60
SULPHATE, UNF.REACT. SSO4UR,MG/L as SO4 Sulphate 003AI0	10.82	7.23	6.18	2.50RRV	7.49RRV	8.74
NITR'N,TOTAL KJELD,UNF.R NNTKUR,MG/L as N (Nitrogen) 004BC2	<.05<W	<.05<W	.30	.50	1.80	.40

```
Environment Ontario           NE37346       PERRY TOWNSHIP                         Page   7
FINAL    REPORT                                                          Printed 23/02/87

Sample Class:  W                          Results

WATER (GRND/DOMESTIC) WQ                       Inquiries at: JENIFER McBRIDE
(Textual information after numerical data)        Telephone: 416-235-5875

--------------------------------------------------------------------------------------------------
   Field Sample Number...         Y-2         Y-3         Y-4         Y-5         Y-6         Y-7
Test Description
Code,  Units of Measure        W03-0071    W03-0072    W03-0073    W03-0074    W03-0075    W03-0076
------------------ Method     ----------- ----------- ----------- ----------- ----------- -----------
NITRATES,TOTL, FRAC.REAC         .30         .40         .55         .30        2.10         .50
NNOTFR,MG/L as N (Nitrogen)
                   102CC2
DISSOLVED ORGANIC CARBON         .1<T       <.1<W        .1<T       1.9          .7         2.8
DOC   ,MG/L as C (Carbon)
                   102AC2
```

```
FINAL    REPORT                                                      Printed  23/02/87

Sample Class:  W                               Results

WATER (GRND/DOMESTIC) WQ                          Inquiries at: JENIFER McBRIDE
(Textual information after numerical data)           Telephone: 416-235-5875

--------------------------------------------------------------------------------------------------
 Field                                  Sampling Location Description      LAB                         Sampling
 Sample  Sampling Location              Sample Description                 Sample#  Remarks    Date    Time Zone
 -------- --------------------          ---------------------------------- -------- -------  --------  ----- ---
     Y-8 CODE NOT GIVEN                 TEST PIT 2 DUMP RD AT HWY 592 CLEAR                  13/01/87          5
                                        NOT GIVEN                          W03-0077
     Y-9 CODE NOT GIVEN                 L21 C5 POND FR POND SOME SEDIMENT                    13/01/87          5
                                        FROM POND SOME SEDIMENT            W03-0078

--------------------------------------------------------------------------------------------------
   Field Sample Number...            Y-8           Y-9
Test Description
Code,  Units of Measure            W03-0077      W03-0078
----------------- Method          ---------- ---------- ---------- ---------- ---------- ----------
CONDUCTIVITY 25C                   193.0          78.2
COND25,UMHO/CM at 25 D.CENT.
                  002BI2
HARDNESS, TOTAL                     60.5          24.0
HARDT ,MG/L as CACO3
                  CALC01
SODIUM, UNF.REACT.                  12.3           3.8
NAUR  ,MG/L as Na (Sodium)
                  002BA1
POTASSIUM, UNF.REACT.                .81          1.24
KKUR  ,MG/L as K (Potassium)
                  002BA1
ALKALINITY,TOTAL                    55.2          19.1
ALKT  ,MG/L as CACO3
                  004AT6
PH (-LOG(H+(CONCN)))                7.95          7.07
PH    ,DIMENSIONLESS
                  003AI2
CHLORIDE, UNF.REACTIVE             20.00          5.35
CLIDUR,MG/L as Cl-  Chloride
                  004AC1
SULPHATE, UNF.REACT.                9.13          7.91
SS04UR,MG/L as S04  Sulphate
                  003AI0
NITR'N,TOTAL KJELD,UNF.R            .20<T          .10<T
NNTKUR,MG/L as N (Nitrogen)
                  004BC2
```

```
Sample Class:  W                           Results

WATER (GRND/DOMESTIC) WQ                         Inquiries at: JENIFER McBRIDE
(Textual information after numerical data)          Telephone: 416-235-5875

---------------------------------------------------------------------------------------

    Field Sample Number...          Y-8         Y-9
Test Description
Code,  Units of Measure          W03-0077    W03-0078
------------------ Method      ----------- ----------- ----------- ----------- ----------- ----------
NITRATES,TOTL, FRAC REAC           .35         .70
NNOTFR,MG/L as N (Nitrogen)
                  102CC2
DISSOLVED ORGANIC CARBON          2.5          .5
DOC   ,MG/L as C (Carbon)
                  102AC2
```

Sample Class: W Textual Information

WATER (GRND/DOMESTIC) WQ Inquiries at: JENIFER McBRIDE
(Textual information after numerical data) Telephone: 416-235-5875

SUBMISSION: NE37346
AUTHORED BY: JENIFER MCBRIDE
THE ION BALANCES FOR SAMPLES Y-5 AND Y-6 DO NOT MEET OUR APPROVAL CRITERION. ALL CATIONS WERE CONFIRMED BY REANANYSIS, AS WELL AS THE SULPHATE AND TOTAL NITRATE ANIONS THE DATA ARE AT OR NEAR DETECTION CRITERION LEVELS FOR DRINKING WATER RANGE.

Sample Class: ##

Results

DERIVED RESULTS

Inquiries at: WATER QUALITY OFFICE
Telephone: 416-248-3512

Field Sample	Sampling Location	Sampling Location Description Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
Y-2	CODE NOT GIVEN	HARVEYS AUTO PERRY FROM TAP GLASS PLASTIC BOTTLE CLEAR	ION-CAL		13/01/87		5
Y-3	CODE NOT GIVEN	CORMACK LOT 23 C5 PERRY FROM TAP CLEAR NOT GIVEN	ION-CAL		13/01/87		5
Y-4	CODE NOT GIVEN	ALMAGON LODGE PERRY FROM TAP CLEAR NOT GIVEN	ION-CAL		13/01/87		5
Y-5	CODE NOT GIVEN	GLAVES L22 C5 PERRY FROM POND CLEAR NOT GIVEN	ION-CAL		13/01/87		5
Y-6	CODE NOT GIVEN	RINESS S OF DUMP PERRY FROM TAP CLEAR NOT GIVEN	ION-CAL		13/01/87		5
Y-7	CODE NOT GIVEN	TEST PIT 1 PERRY LOW AREA OF DUMP CLEAR NOT GIVEN	ION-CAL		13/01/87		5

Field Sample Number... Test Description Code, Units of Measure Method	Y-2 ION-CAL	Y-3 ION-CAL	Y-4 ION-CAL	Y-5 ION-CAL	Y-6 ION-CAL	Y-7 ION-CAL
ION BALANCE CALCULATION CONDTY,UMHO/CM AT 25C	92.98	73.98	74.70	13.13	54.30	157.8
ION BALANCE CALCULATION DISOL ,MG/L	46.84	37.64	37.71	7.352	31.04	78.83
ION BALANCE CALCULATION IONBL ,%	3.493	11.34	11.13	125.0	34.70	7.845

Sample Class: ## Results

DERIVED RESULTS

Inquiries at: WATER QUALITY OFFICE
Telephone: 416-248-3512

Field Sample	Sampling Location	Sampling Location Description Sample Description	LAB Sample#	Remarks	Sampling Date	Time	Zone
Y-8	CODE NOT GIVEN	TEST PIT 2 DUMP RD AT HWY 592 CLEAR NOT GIVEN	ION-CAL		13/01/87		5
Y-9	CODE NOT GIVEN	L21 C5 POND FR POND SOME SEDIMENT FROM POND SOME SEDIMENT	ION-CAL		13/01/87		5

Field Sample Number... Test Description Code, Units of Measure Method	Y-8 ION-CAL	Y-9 ION-CAL
ION BALANCE CALCULATION CONDTY,UMHO/CM AT 25C	200.1	81.85
ION BALANCE CALCULATION DISOL ,MG/L	98.30	41.31
ION BALANCE CALCULATION IONBL ,%	6.711	10.44

REMARK CODE EXPLANATIONS

RMK	DESCRIPTION
<	ACTUAL RESULT IS LESS THAN THE REPORTED VALUE
<T	THIS LOW MEASUREMENT IS TENTATIVE. FOR INFO ONLY
<W	"ZERO". VALUE REPORTED IS MIN. MEASURABLE AMOUNT
RRV	REPORTED RESULT VERIFIED BY REPEAT ANALYSIS

*** END OF REPORT ***

APPENDIX C

PRIVATE WELL LOG

SUMMARY

SUMMARY OF PRIVATE & OBSERVATION WELL LOGS

Well	Driller's Log		Remarks
1 MoE 744 Norman Simcoe	Fine sand Gravel Gravel & boulders Granite	0 - 40 40 - 72 72 - 92 92 - 95	Q = 2 gpm SL = 36 ft PL = 36 ft (1 hr) Q/s = NA 2" dia. casing Fresh water at 96 ft Date: Dec. 14, 1965
1b MoE 742 E. Simcoe	See MoE Record for Log #744		Q = NA SL = NA PL = NA (1 hr) Q/s = NA 1 1/2" dia. casing Dry well Date: July 20, 1966
1c MoE 746 E. Simcoe	NA		Q = NA SL = NA PL = NA (1 hr) Q/s = NA 1 1/2" dia. casing Dry hole Date: July 21, 1966
2 MoE 1204 Craig Crozier	Brown gravel Grey clay & brown gravel Brown sand	0 - 60 60 - 70 70 - 83	Q = 5 gpm SL = 23 ft PL = 71 ft (1 hr) Q/s = .1 gpm/ft 5" dia. casing Fresh water at 76 ft Date: Sept. 25, 1970
4 MoE 2353 Craig Crozier	Brown gravel	0 - 75'7"	Q = 10 gpm SL = 60 ft PL = NA (1 hr) Q/s = NA 6" dia. casing Fresh water at 75 ft Date: May 2, 1977

5	Fine sand	0 - 20	Q = 1.5 gpm
MoE 745	Gravel	20 - 23	SL = 65 ft
Kerry Crozier	Fine sand	23 - 30	PL = 75 ft (1 hr)
	Hardpan	30 - 72	Q/s = NA
	Boulders	72 - 75	2" dia. casing
	Coarse gravel	75 - 85	Fresh water at 80 ft
			Date: Jan. 21, 1964
6	Dug well	0 - 16	Q = 400 gph
MoE 743	Drilled granite	16 - 135	SL = well flowing
Gerald Stoeher			above ground
			PL = NA (1 hr)
			Q/s = NA
			2" dia. casing
			Fresh water at 133 ft
			Date: Apr. 7, 1964
7	Brown sand	0 - 31	Q = 5 gpm
MoE 3306	Grey clay, boulders,	31 - 96	SL = 30 ft
Jack Marshall	quicksand & broken rock		PL = NA (4.5 hrs)
	Grey & red bedrock	96 - 145	Q/s = NA
	(granite)		6" dia. casing
			Fresh water at 141 ft
			Date: Sept. 23, 1981
8	Grey clay	0 - 22	Q = 10 gpm
MoE 2506	Grey gravel & clay	22 - 55	SL = 34 ft
Rick York	Brown gravel	55 - 61	PL = 57 ft (1 hr)
			Q/s = NA
			6" dia. casing
			Fresh water at 61 ft
			Date: Nov. 2, 1977
9	Brown sand & gravel	0 - 87	Q = 12 gpm
MoE 1057	Gravel	87 - 91	SL = 30 ft (1 hr)
H. Sollman			PL = 30 ft
			Q/s = 24 gpm/ft
			2" dia. casing
			Fresh water at 91 ft
			Date: May 28, 1969
10	Brown gravel & boulders	0 - 55	Q = 2 gpm
MoE 1351	Grey granite	55 - 215	SL = 50 ft
G. Dryburgh			PL = 215 ft (1 hr)
			Q/s = 0 gpm/ft
			5" dia. casing
			Fresh water at 213 ft
			Date: Oct. 4, 1971

MBL WELL SURVEY

Well	Driller's Log	Remarks
11 MoE - NA Peter Fetterley	Dug well	None available The Fetterleys moved into this house on June 1, 1988
12 MoE - NA Duncan Marshall	Dug well	Q = NA SL = 17 ft PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1963
13 MoE - NA Douglas Hughes	Dug well	Q = NA SL = 7 ft PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1964
14 MoE 743 Gerald Stoeher	Refer to well # 6 Private Well Record Survey	Refer to well #6 Private Well Record Survey
15 MoE - NA Cecil G. Gilpin	Dug well	Q = NA SL = 13 ft PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1978
16 MoE - NA Irwin Marshall	Dug well	Q = NA SL = NA PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1963

17 MoE - NA Warehouse for Twp. of Perry	Dug well	Q = NA SL = 9 ft PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1979
18 P. Stanley	Dug well	Q = NA SL = NA PL = NA Q/s = NA 36" dia. casing Date: NA
19 MoE - NA Douglas Powell	Dug well	Q = NA SL = 12 ft PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1969
20 MoE - NA Christine Nolan	Dug well	Q = NA SL = 9 ft PL = NA Q/s = NA 36" dia. casing Fresh water NA Date: 1971

APPENDIX D

BOREHOLE and TEST PIT LOGS

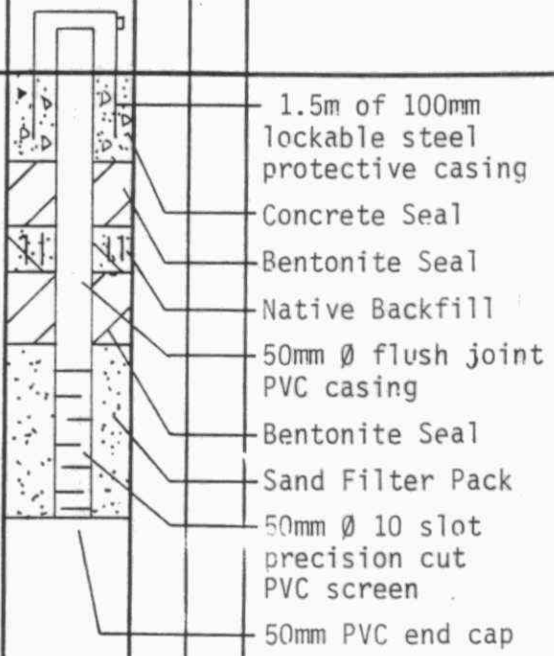
morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, l2a, mississauga, ontario (416) 624 - 9308

OW1-5

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"
silty SAND; fine, trace med-coarse sand, trace gravel, occasional boulder, loose to compact with depth, brown, moist, sat'd below 2.1m		5	1	SS	153
	2				
		10	2	SS	NA
	4				
END OF HOLE 4.57m		15	3	SS	NA
	6	20			
		25			
	8				
		30			
	10				
		35			
	12	40			
		45			
	14				

WELL DETAIL


1.5m of 100mm lockable steel protective casing
Concrete Seal
Bentonite Seal
Native Backfill
50mm Ø flush joint PVC casing
Bentonite Seal
Sand Filter Pack
50mm Ø 10 slot precision cut PVC screen
50mm PVC end cap

REMARKS
BLOWS PER FOOT
10 20 30 40 50 60 70 80 90

GS- GRAB SAMPLE SS - SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12a, mississauga, ontario (416) 624 - 9308

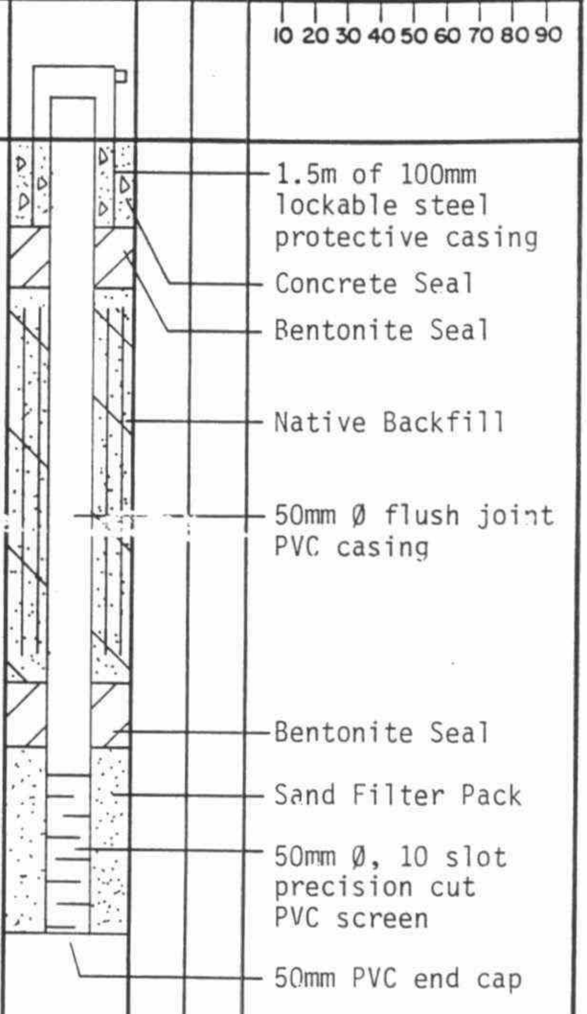
OW1-8

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"
silty SAND; fine, trace med-coarse sand, trace gravel, occasional boulder, loose to very dense with depth, brown, moist, sat'd below 2.1m		5	1	SS	153
	2				
		10	2	SS	NA
	4				
		15	3	SS	NA
	6	20	4	SS	NA
occasional 1mm thick layer of clayey silt between 5.5-8.0m		25	5	SS	NA
	8				
END OF HOLE 8.23m		30			
	10				
		35			
	12	40			
		45			
	14				

WELL DETAIL

REMARKS
BLOWS PER FOOT


10 20 30 40 50 60 70 80 90
1.5m of 100mm lockable steel protective casing
Concrete Seal
Bentonite Seal
Native Backfill
50mm Ø flush joint PVC casing
Bentonite Seal
Sand Filter Pack
50mm Ø, 10 slot precision cut PVC screen
50mm PVC end cap

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

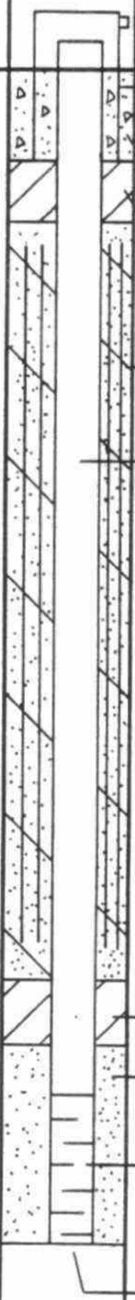
morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12a, mississauga, ontario (416) 624 - 9308

OW1-13

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"
silty SAND; fine, trace med-coarse sand, trace gravel, occasional boulder, loose to v. dense with depth, brown, moist, sat'd below 2.1 m.	2	5	1	SS	153
	4	10	2	SS	NA
		15	3	SS	NA
occasional 1mm thick layer of clayey silt between 5.5-8.0m bgl.	6	20	4	SS	NA
	8	25	5	SS	NA
	10	30	6	SS	NA
1.3m Ø boulder 10.0-11.3m		35	7	SS	NA
end of hole 12.3m.	12	40			
	14	45			

WELL DETAIL



REMARKS
BLOWS PER FOOT
10 20 30 40 50 60 70 80 90

1.5m of 100mm lockable steel protective casing
Concrete Seal
Bentonite Seal
Native Backfill
50mm Ø flush joint PVC casing
Bentonite Seal
Sand Filter Pack
50mm Ø, 10 slot precision cut PVC screen
50mm PVC end cap

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

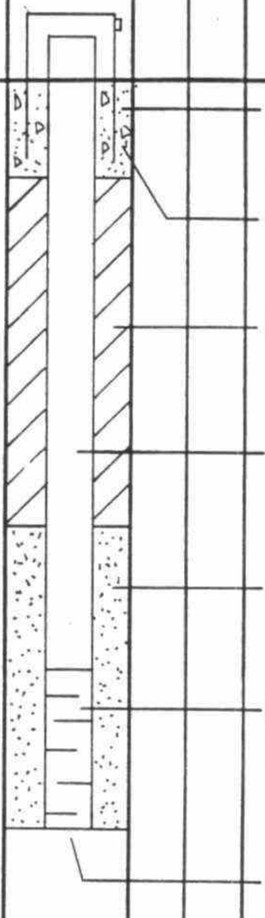
morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12a, mississauga, ontario (416) 624 - 9306

OW2-8

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"
SAND & GRAVEL; fine to coarse sand, trace of cobble and boulders, loose to compact with depth, brown, moist		5	1	SS	67
	2	10	2	SS	NA
sat'd below 4.6m	4	15	3	SS	NA
	6	20	4	SS	NA
SAND; fine, trace med-coarse sand, some gravel and boulders, dense, brown, sat'd		25	5	SS	NA
END OF HOLE 7.77m	8	30			
	10	35			
	12	40			
	14	45			

WELL DETAIL



REMARKS
BLOWS PER FOOT
10 20 30 40 50 60 70 80 90

1.5m of 100mm lockable steel protective casing
Concrete Seal
Bentonite Seal
50mm Ø flush joint PVC casing
Sand Filter Pack
50mm Ø 10 slot precision cut PVC screen
50mm PVC end cap

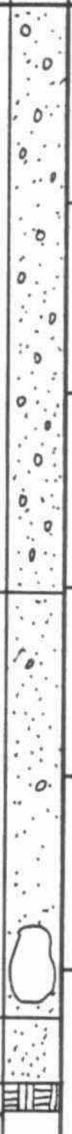
GS- GRAB SAMPLE SS - SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, l2e, mississauga, ontario (416) 624 – 9308

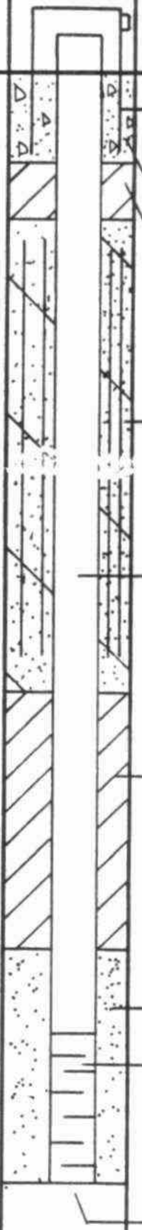
OW2-12

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"
SAND & GRAVEL; fine to coarse sand, trace cobbles and boulders, loose to compact with depth, brown, moist		5	1	SS	67
	2	10	2	SS	NA
sat'd below 4.6m	4	15	3	SS	NA
	6	20	4	SS	NA
SAND; fine, trace med-coarse sand, some gravel and boulder, dense, brown, sat'd	8	25	5	SS	NA
		30	6	SS	NA
1.0m Ø boulder at 9.6 to 10.6m	10				
SAND; v. fine to fine, v. dense, brown, sat'd		35	7	SS	NA
ROCK; (assumed bldr.)					
END OF HOLE 11.61m	12	40			
	14	45			



WELL DETAIL


1.5m of 100mm lockable steel protective casing
Concrete Seal
Bentonite Seal
Native Backfill
50mm Ø flush joint PVC casing
Bentonite Seal
Sand Filter Pack
50mm Ø, 10 slot precision cut PVC screen
50mm PVC end cap

REMARKS
BLOWS PER FOOT
10 20 30 40 50 60 70 80 90

GS- GRAB SAMPLE · SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

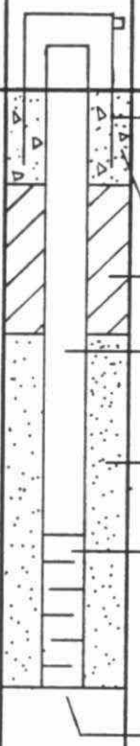
morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12a, mississauga, ontario (416) 624 – 9308

OW3-6

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"
SAND; v. fine to fine, some silt, loose, brown, moist sat'd below 2.5m	2	5	1	SS	NA
silty SAND & GRAVEL; fine to coarse sand, occasional cobble and boulder, compact, brown, sat'd	4	10	2	SS	NA
SAND; fine to medium grain, v. dense, black with brown streaks, sat'd	6	15 20	3 4	SS SS	NA NA
END OF HOLE 6.19m	8 10 12 14	25 30 35 40 45			

WELL DETAIL



REMARKS
BLOWS PER FOOT
10 20 30 40 50 60 70 80 90

1.5m of 100mm lockable steel protective casing
Concrete Seal
Bentonite Seal
50mm Ø flush joint PVC casing
Sand Filter Pack
50mm Ø 10 slot precision cut PVC screen
50mm PVC end cap

WL-040281

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12a, mississauga, ontario (416) 624 – 9308

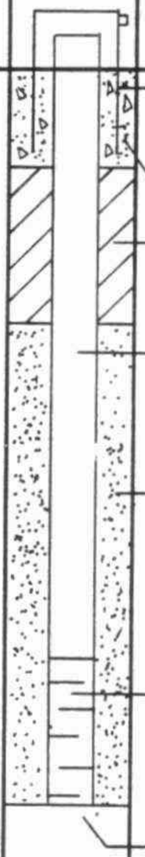
OW4-8

CLIENT MoE- Waste Management Branch FILE NO. 628-881
PROJECT Closed Waste Site Study LOCATION Elmsdale Landfill
GEOLOGIST/ENGINEER LDH DATE COMPLETED December 4, 1988

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	REMARKS
silty SAND & GRAVEL; fine to coarse sand, occasional cobble and boulder, dense, grey, sat'd						1.5m of 100mm lockable steel protective casing Concrete Seal
silty SAND; fine, trace med-coarse sand, some gravel, occasional cobble and boulder, dense, brown, sat'd		5	1	SS	NA	Bentonite Seal
	2	10	2	SS	NA	50mm Ø flush joint PVC casing
	4	15	3	SS	NA	Sand Filter Pack
	6	20	4	SS	NA	50mm Ø, 10 slot precision cut PVC screen
		25	5	SS	NA	
END OF HOLE 7.92m	8					50mm PVC end cap
		30				
	10	35				
	12	40				
	14	45				

REMARKS BLOWS PER FOOT: 10 20 30 40 50 60 70 80 90

WELL DETAIL



GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 1				
SAND, fine to medium, with boulders to 1.5m Ø, loose, brown, damp.	1	2	No well installed	
Backhoe refusal 0.9m	2 3	4 6 8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 2				
SAND, fine to medium, with boulders to 1.5m Ø, loose, brown, damp.	1	2	No well installed	Water seepage at 1.1 m.b.g.l.
SAND & GRAVEL, fine to coarse, with boulders to 1.5m Ø, loose, brown, wet.		4		
SAND, fine, loose to compact,npact, brown, moist to wet.				
Backhoe refusal 1.7m	2 3	6 8		

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416-624-9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 3				
SAND FILL, fine, loose, brown, damp.			No well installed	
SAND & GRAVEL, fine sand, loose, brown, damp to moist with depth.	1	2 4 6		Water seepage at 1.5 m.b.g.l.
SAND with BOULDERS, fine, boulders to 1.5 Ø, loose, brown, wet.	2			
Backhoe refusal 2.1m.	3	8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 4				
SAND FILL, loose,brown, damp.				
SAND & REFUSE, fine sand, glass and tin and paper, loose, dark brown, moist.		2		Water seepage at 1.5 m.b.g.l.
SAND with gravel to boulders to 1.5m Ø, fine to coarse, loose, brown, moist to saturated.	1	4		
Backhoe refusal 1.7m.	2 3	6 8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 5				
TOPSOIL with boulders to 1.5m 0, loose, dark brown, damp.			No well installed	
SAND, fine, occasional boulder, loose to compact, red-orange becoming tan, moist.	1	2 4		
SAND with gravel, boulders to 1.5m 0, loose to compact, brown, moist.	2	6		
Backhoe refusal 2.0m.	3	8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 6				
TOPSOIL & REFUSE, loose.			No well installed	
SAND, fine, loose, yellow to tan.	1	2		
End of test pit 1.2m.	2 3	4 6 8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 7				
SAND, fine grain, loose, yellow-buff.			No well installed	
SAND, fine, with cobbles to boulders, loose, buff, dry.	1	2		
End of test pit 1.2m	2 3	4 6 8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 8				
TOPSOIL, loose, dark brown.			No well installed	
SAND, fine to medium, loose, yellow to red.	1	2 4		Water seepage at 1.5m.
SAND with gravel to boulders.				
End of test pit 1.7m	2 3	6 8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETAIL	REMARKS
Test Pit 9				
Sandy TOPSOIL.			No well installed	Attempting to locate caustic waste
SAND, fine to medium, yellow brown.				
Silty SAND, very fine to fine, yellow to olive, loose.	1	2		
End of test pit 1.0m	2 3	4 6 8		

DESCRIPTION	DEPTH metres	DEPTH feet	WELL DETA	REMARKS
Test Pit 10				
REFUSE, waste metal, plastic with sand.	1	2		
End of test pit 1.0m	2 3	4 6 8		

APPENDIX E

GRAIN SIZE CURVES

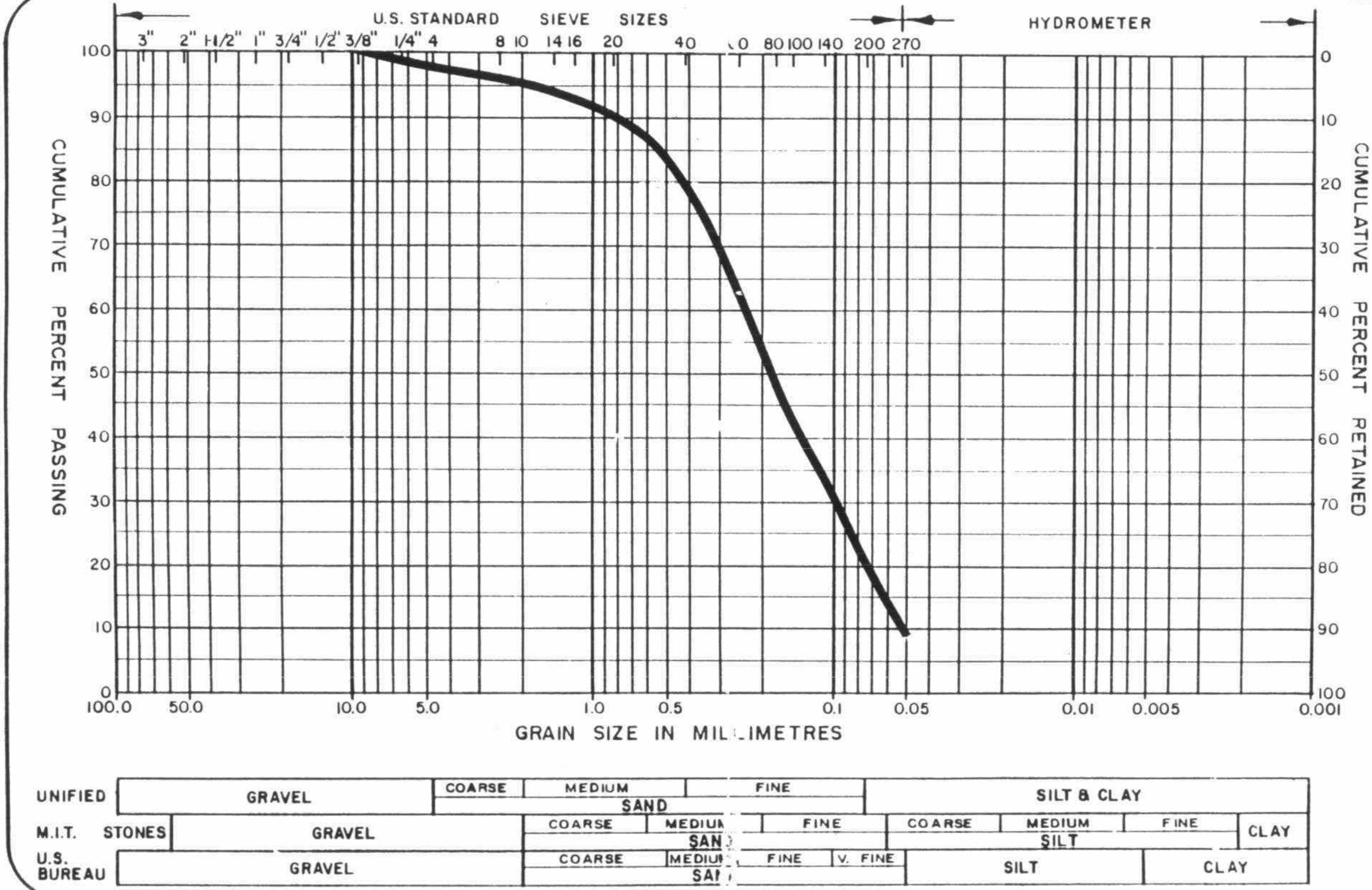
65-05078

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 1-13
Sample No.: SS-1
Sample Depth.: .9-1.4m

E-1



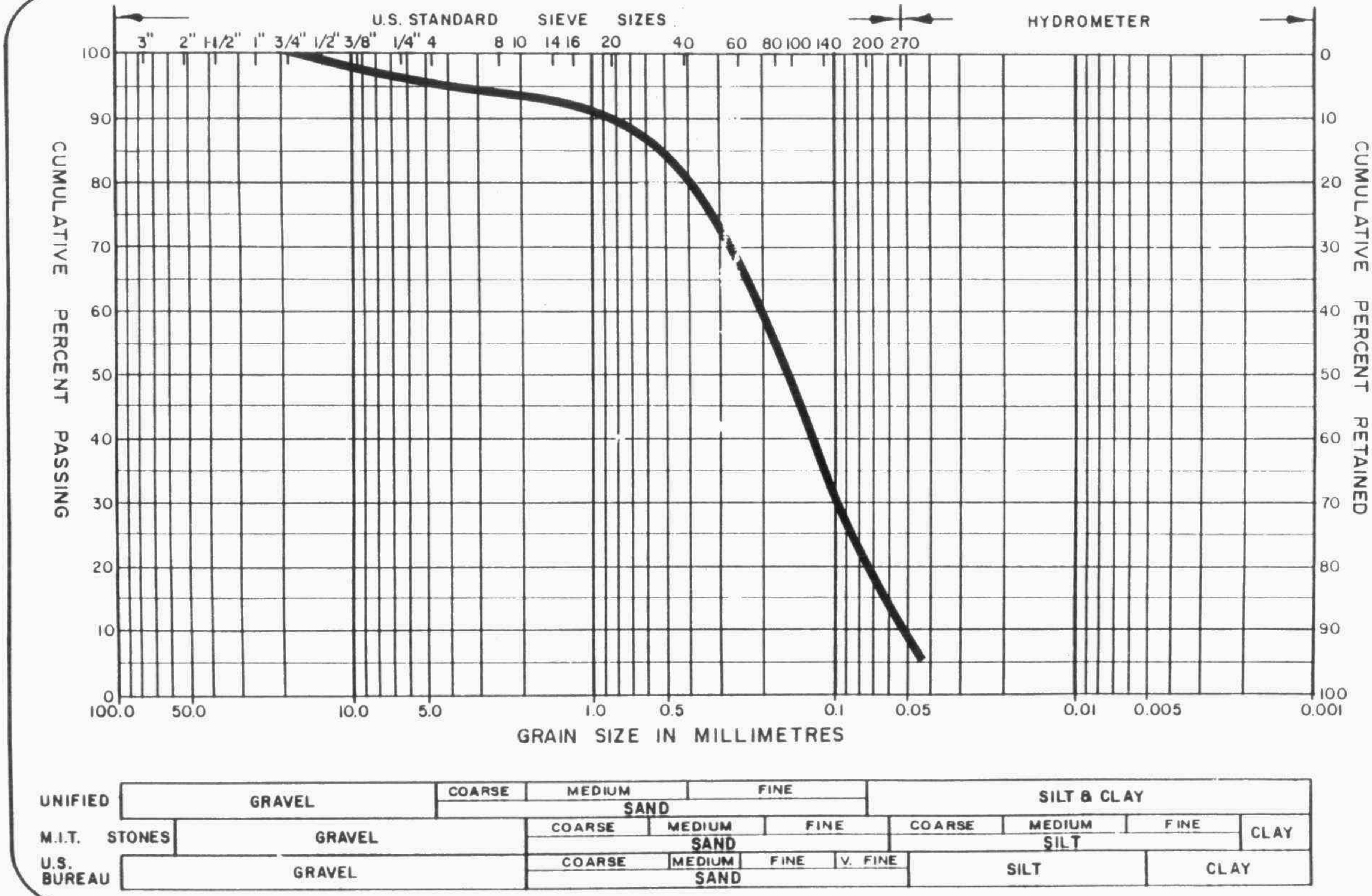
65 - 050781

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 1-13
Sample No.: SS-2
Sample Depth.: 4.0-4.4m

E-2



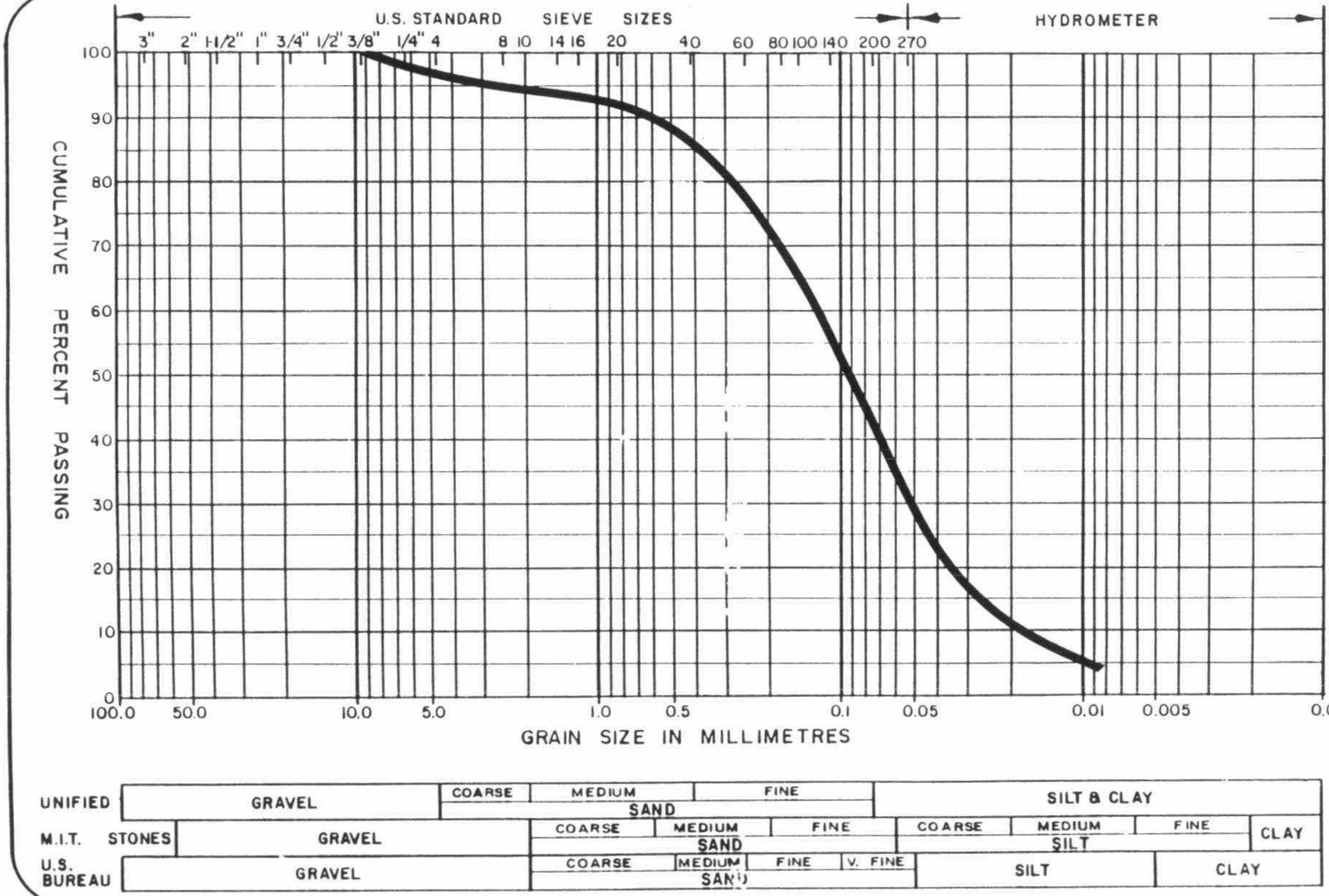
85 - 050781

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 1-13
Sample No.: SS-5
Sample Depth.: 7.2-7.6m

E-3



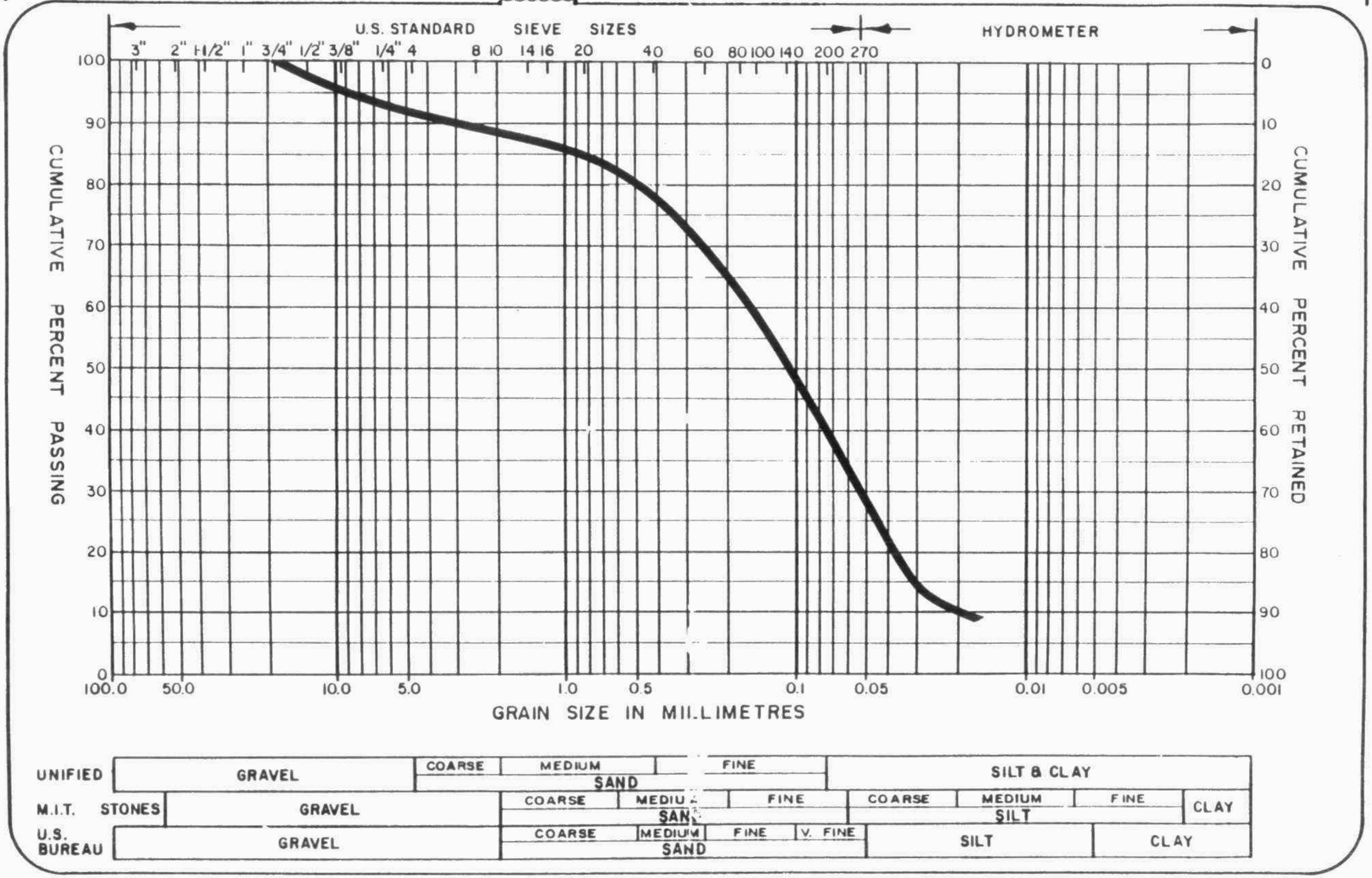
65 - 050781

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Land III Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 1-13
Sample No.: SS-8
Sample Depth.: 12.2-12.3m

E-4



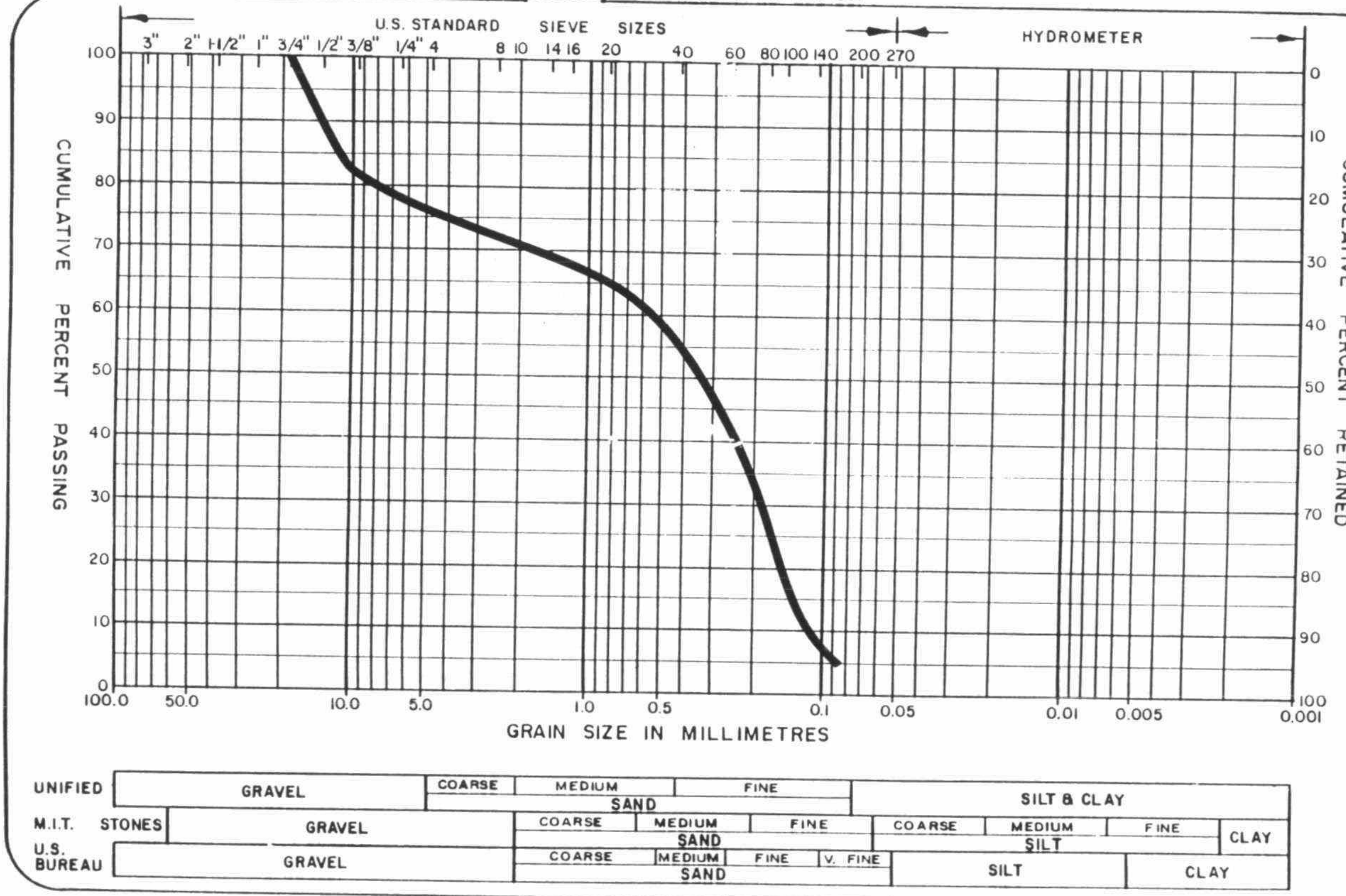
morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

85 - 060781

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 2-12
Sample No.: SS-2
Sample Depth.: 3.0-3.4m

E-5



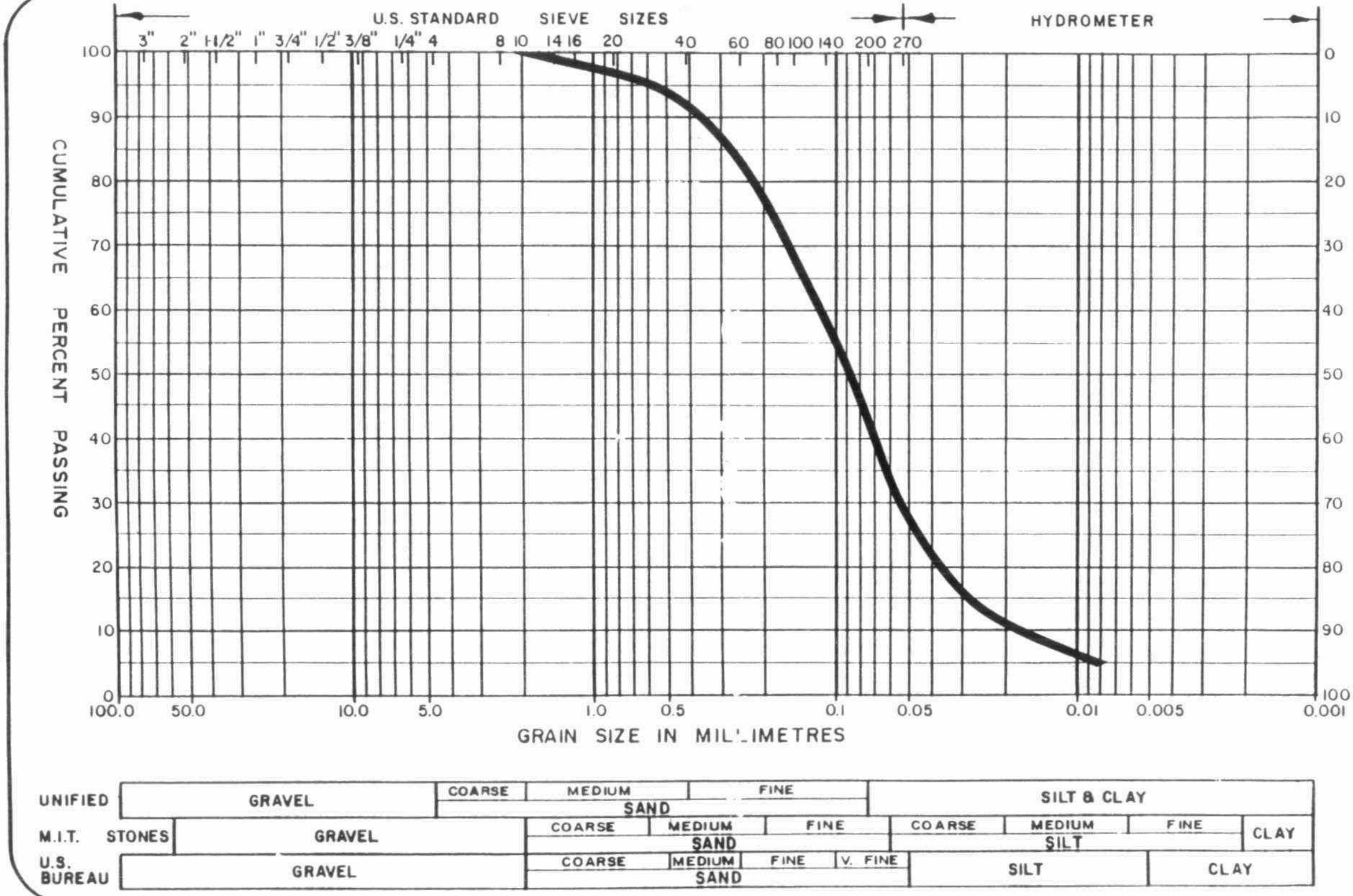
95 - 050781

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 2-12
Sample No.: SS7
Sample Depth.: 10.7-11.1m

E-6



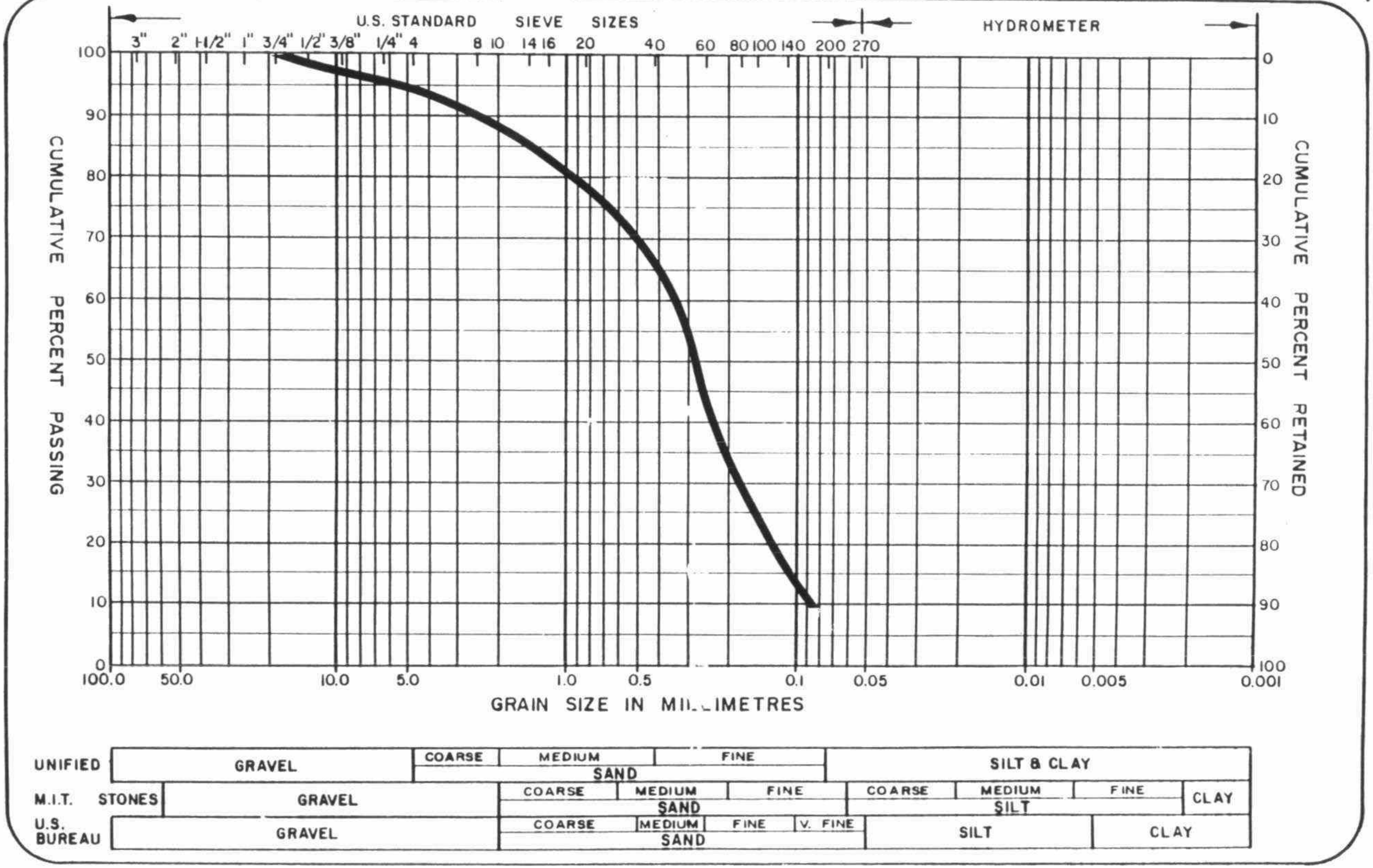
85 - 05078

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 3-6
Sample No.: SS-4
Sample Depth.: 6.1-6.2m

E-7



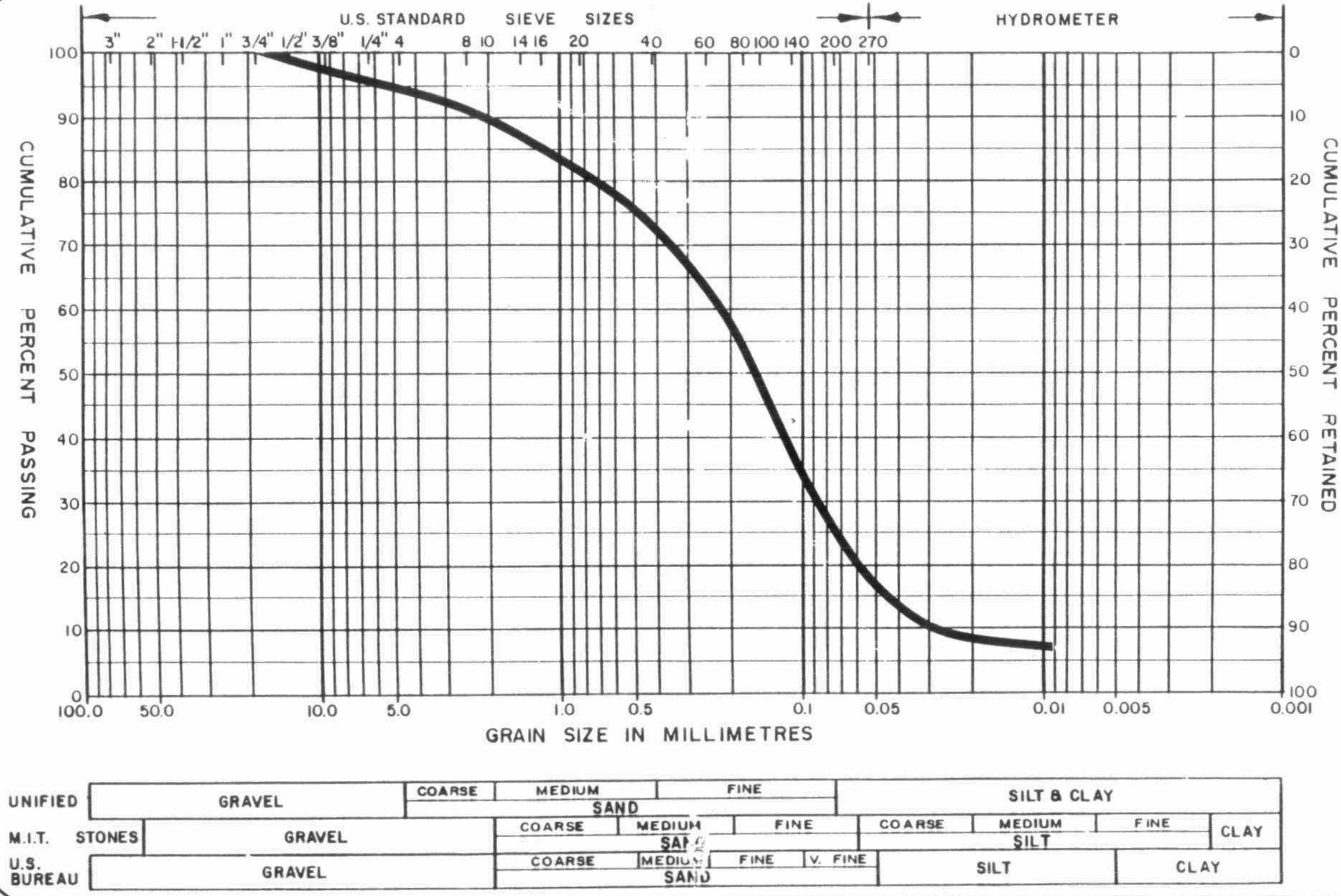
85 - 060781

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416 624 9308)

MINISTRY of the ENVIRONMENT
Waste Management Branch
Closed Landfill Study
Emsdale Landfill
PROJECT No. 628-881

Well No.: 4-8
Sample No.: SS5
Sample Depth.: 7.6-7.9m

E-8



FIELD MONITORING DATA

APPENDIX F

APPENDIX F

FIELD HYDRAULIC CONDUCTIVITY TESTS

The recovery test is included as a standard field method used by hydrogeologists to evaluate the in situ hydraulic conductivity (K) of soils. This method is often applied to observation wells (piezometers and standpipes) where the soil K is too low for normal pumping tests or the diameter of the well casing is insufficient to admit standard pumping apparatus. Such tests may be used to replace the more elaborate pumping methods of aquifer analysis.

The recovery test employed at the Emsdale site includes the analytical techniques developed by Hvorslev (1951). This method is based upon the rate of water level rise or fall in a defined space (the well casing and the well point filter).

Hvorslev Method

The time lag/variable head technique for determining soil hydraulic conductivity in observation wells was described by M. Juul Hvorslev in 1951. His paper defines various errors and correction factors that may be introduced during the analysis of water level response in observation wells. The paper lists several methods of dealing with unrecovered water levels following construction of observation wells (where low K soils produce slow recovery rates and long equalization ratios). The most useful of the Hvorslev methods is the application of a basic time lag factor to calculations of horizontal hydraulic conductivity (K_h), the velocity at which water moves horizontally through a particular soil at an existing hydraulic gradient.

For the wells tested, K_h was equated to vertical hydraulic conductivity (K_v). Thus, the values of K are equivalent to a field coefficient of permeability, a general term which implies an average omnidirectional K.

The Hvorslev time lag equations were developed for well point filters in (a) uniform soil (water table conditions) and (b) at an impervious boundary (as in a confined sand unit or where comparatively permeable soils lie within a uniform, less permeable unit). These equations are described below.

For a well point filter in uniform soil,

1)

$$k = \frac{d^2 \cdot \ln\left(\frac{2ML}{D}\right)}{8 \cdot L \cdot T}$$

where: k = hydraulic conductivity (cm/sec)
d = diameter of well casing (cm)
D = diameter of well point filter (cm)
L = length of well point filter (cm)
M = the square root of the ratio of horizontal to vertical hydraulic conductivity (assumed to be 1.0), and
T = basic Hvorslev time lag (sec)

A shape factor 'F' may be defined for a particular well by

2)

$$F = \frac{d^2 \cdot \ln\left(\frac{2ML}{D}\right)}{8 \cdot L}$$

Equation 1) can then be simplified to

3)

$$k = (F)\left(\frac{1}{T}\right)$$

The time lag T is obtained from a semi-logarithmic graph of residual drawdown and elapsed time from test start-up. The basic time lag T corresponds to a head equalization ratio of 0.37 and is selected from the resultant straight-line graph. The techniques and variables used in this calculation are described in Figure F-1. Figures F-2 to F-8 present the semi-log graphs for the wells tested at the Emsdale site.

Where insufficient recovery data prohibited the use of the basic time lag equation, the following Hvorslev variable head formula was used.

4)

$$k = \frac{d \cdot \ln\left(\frac{2ML}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2}$$

where d, D, L, and m comprise the shape factor 'F' defined in equation 2. The variables t_1, t_2, H_1 and H_2 are defined as in Figures F-1, case B. Equations 1 and 4 produce correlative results where both time lag and variable head calculations are possible.

For cases involving a well point filter at an impervious boundary, Hvorslev developed the following equations.

5) for the basic time lag solution,

$$k = \frac{d^2 \cdot \ln\left(\frac{4ML}{D}\right)}{8 \cdot L \cdot T}$$

and

6) for the variable head solution.

$$k = \frac{d^2 \cdot \ln\left(\frac{4ML}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2}$$

All variables are defined as in equations 1) and 4).

The results of the Hvorslev recovery tests can be described more realistically by averaging the hydraulic conductivities for similar soil units. The results of the in situ hydraulic conductivity tests are presented on the following table.

TABLE F-1

SUMMARY OF FIELD HYDRAULIC CONDUCTIVITY TESTING

Well No.	K (cm/sec)
1-5	4.2×10^{-4}
1-8	1.7×10^{-3}
1-13	8.0×10^{-4}
2-12	1.0×10^{-4}
3-6	1.0×10^{-5}
4-8	7.5×10^{-5}

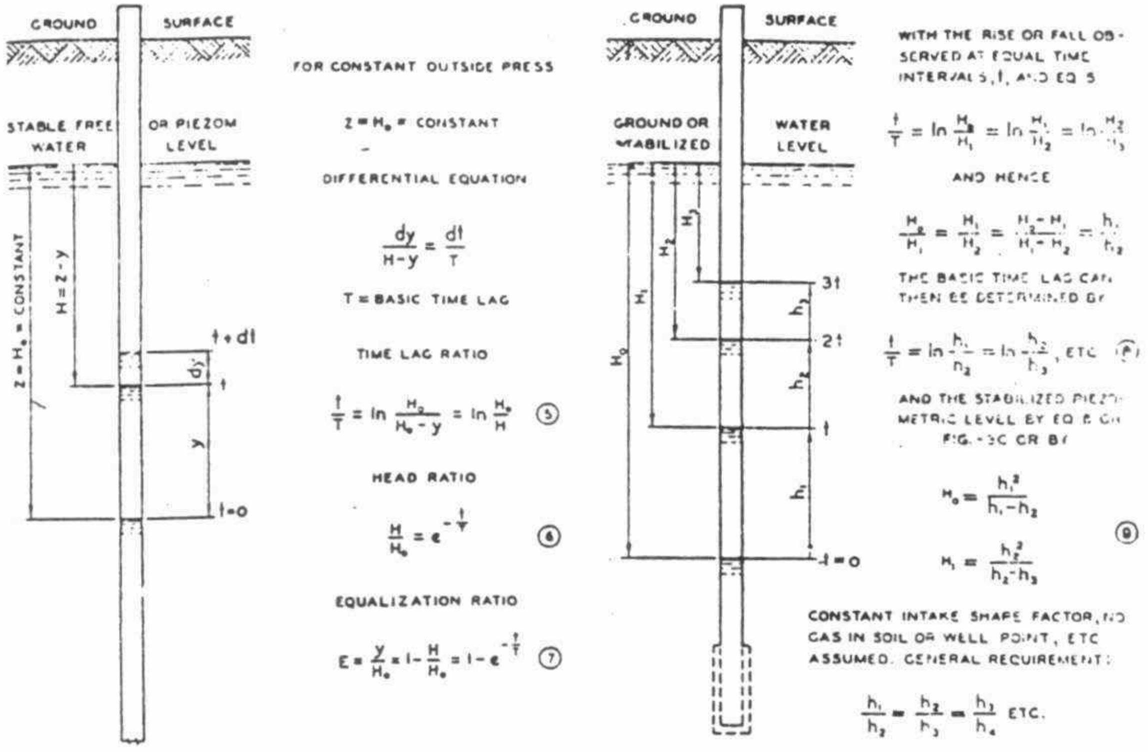
Calculated hydraulic conductivities are derived by applying the Basic Time Lag calculation (Hvorslev 1951) to the results of baildown/recovery tests conducted on each well. The test date was January 10, 1989.

TAbLE F-2

WATER LEVEL ELEVATIONS

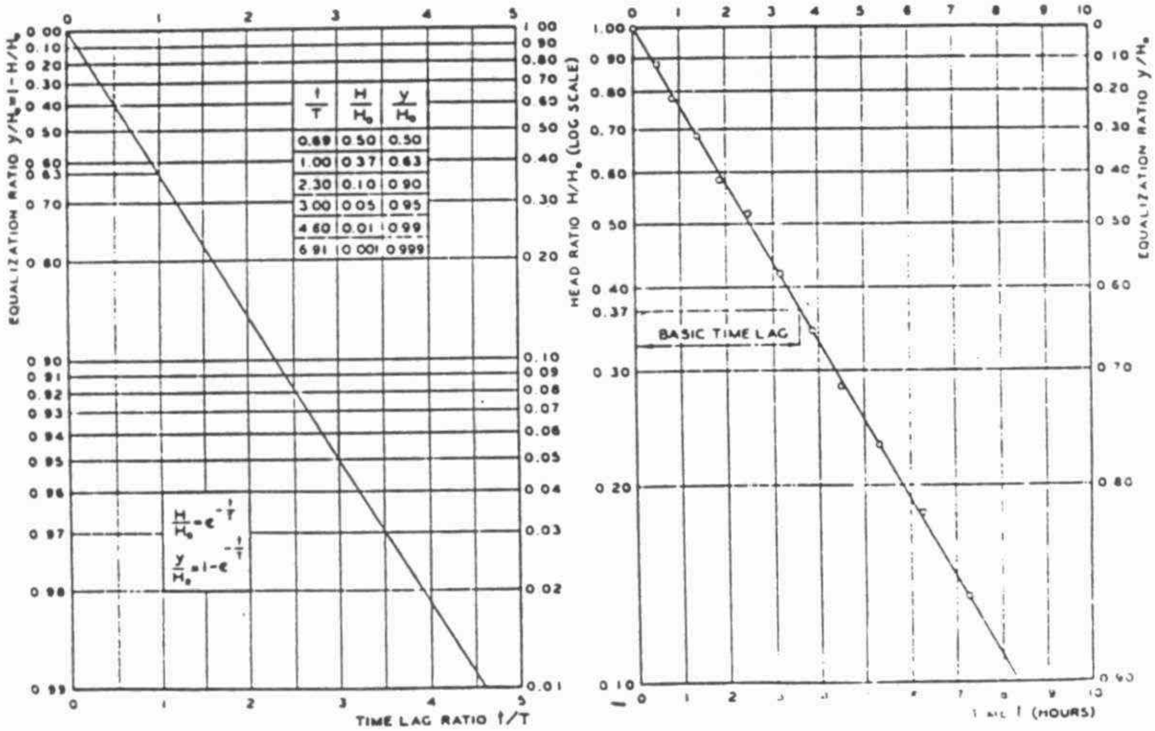
Well #	Measuring Point Elevations		Approximate Geodetic Water Level Elevtaions*				
	Relative Elev.	Assumed Geodetic Elev.*	Dec. 3/88	Dec. 4/88	Dec. 5/88	Jan. 9/89	Jan. 10/89
1-5	101.77	353.64	351.85	NA	NA	350.63	350.63
1-8	101.89	353.75	351.85	NA	NA	350.63	350.63
1-13	101.90	353.76	351.53	NA	NA	350.33	350.33
2-8	103.84	355.71	351.08	NA	NA	350.47	350.47
2-12	103.75	355.60	350.84	NA	NA	350.01	350.01
3-6	113.25	365.12	NA	361.72	NA	NA	360.92
4-8	99.62	351.48	NA	NA	349.11	NA	348.52

* Elevations based on a Temporary Bench Mark established on site. Elevation of the TBM assumed at 100.0 m converted to an estimated geodetic elevation of 351.86 m


GROUND SURFACE
STABLE FREE WATER OR PIEZOM LEVEL
$Z = H_o$ = CONSTANT
$H = Z - y$
$t + dt$
dy
t
y
$t = 0$
FOR CONSTANT OUTSIDE PRESS
$Z = H_o$ = CONSTANT
DIFFERENTIAL EQUATION
$\frac{dy}{H-y} = \frac{dt}{T}$
T = BASIC TIME LAG
TIME LAG RATIO
$\frac{t}{T} = \ln \frac{H_o}{H_o - y} = \ln \frac{H_o}{H}$ ⑤
HEAD RATIO
$\frac{H}{H_o} = e^{-\frac{t}{T}}$ ⑥
EQUALIZATION RATIO
$E = \frac{y}{H_o} = 1 - \frac{H}{H_o} = 1 - e^{-\frac{t}{T}}$ ⑦
GROUND SURFACE
GROUND OR STABILIZED WATER LEVEL
H_o
H_1
H_2
H_3
h_1
h_2
h_3
3t
2t
t
t = 0
WITH THE RISE OR FALL OBSERVED AT EQUAL TIME INTERVALS, t, AND EQ 5
$\frac{t}{T} = \ln \frac{H_o}{H_1} = \ln \frac{H_1}{H_2} = \ln \frac{H_2}{H_3}$
AND HENCE
$\frac{H_o}{H_1} = \frac{H_1}{H_2} = \frac{H_o - H_1}{H_1 - H_2} = \frac{h_1}{h_2}$
THE BASIC TIME LAG CAN THEN BE DETERMINED BY
$\frac{t}{T} = \ln \frac{h_1}{h_2} = \ln \frac{h_2}{h_3}$, ETC ⑧
AND THE STABILIZED PIEZOMETRIC LEVEL BY EQ 8 OR FIG. 3C OR BY
$H_o = \frac{h_1^2}{h_1 - h_2}$
$H_1 = \frac{h_2^2}{h_2 - h_3}$ ⑨
CONSTANT INTAKE SHAPE FACTOR, NO GAS IN SOIL OR WELL POINT, ETC ASSUMED. GENERAL REQUIREMENT:
$\frac{h_1}{h_2} = \frac{h_2}{h_3} = \frac{h_3}{h_4}$ ETC.

A - GENERAL CASE

B - OBSERVATIONS AT EQUAL TIME INTERVALS



$\frac{t}{T}$	$\frac{H}{H_o}$	$\frac{y}{H_o}$
0.69	0.50	0.50
1.00	0.37	0.63
2.30	0.10	0.90
3.00	0.05	0.95
4.60	0.01	0.99
6.91	0.001	0.999

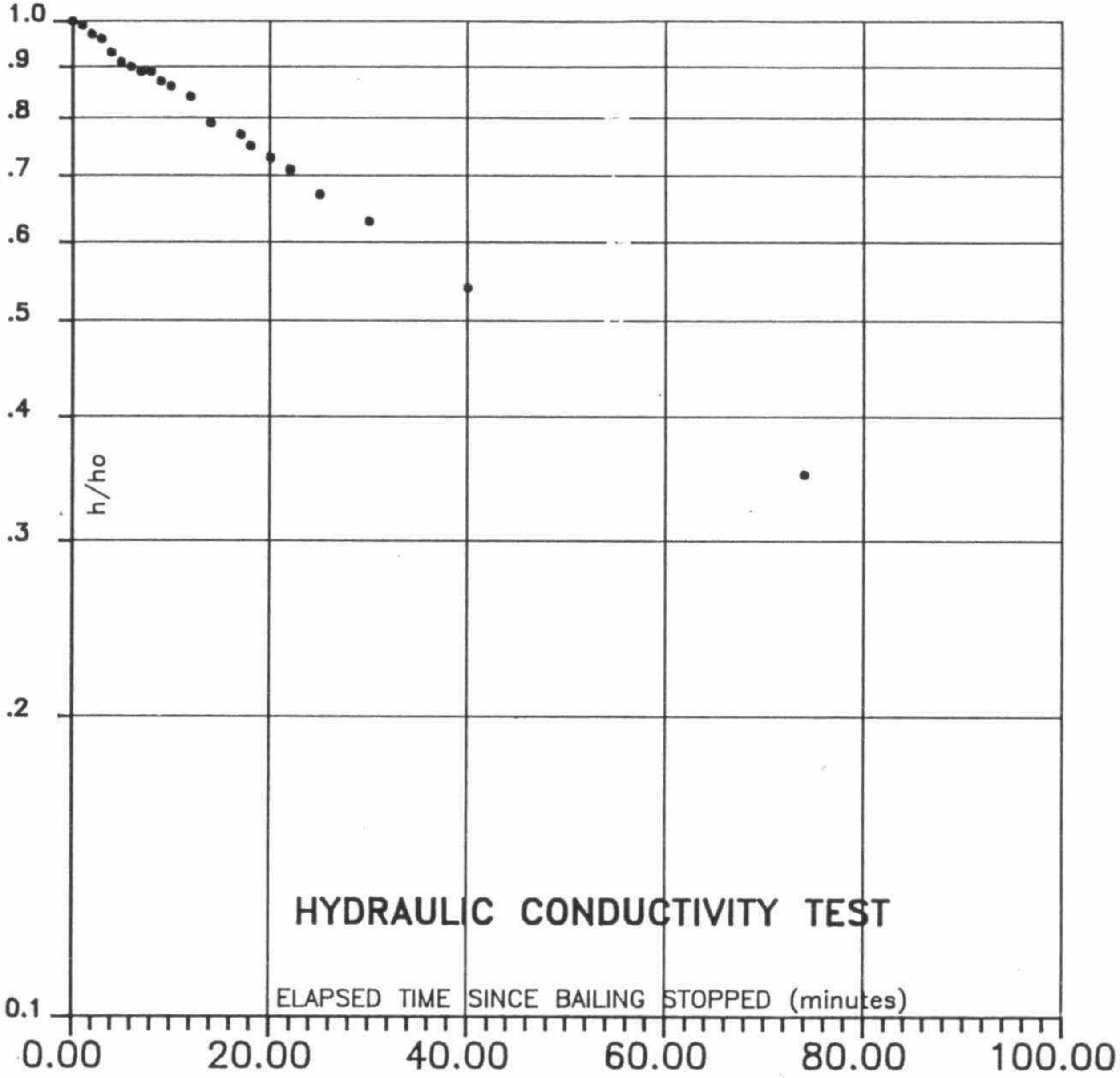
C - HEAD AND EQUALIZATION RATIOS

D - DETERMINATION OF BASIC TIME LAG

HEAD AND TIME RELATIONSHIPS (after Hvorslev, 1951)

morrison beatty limited
consulting engineers and hydrogeologists

F-1



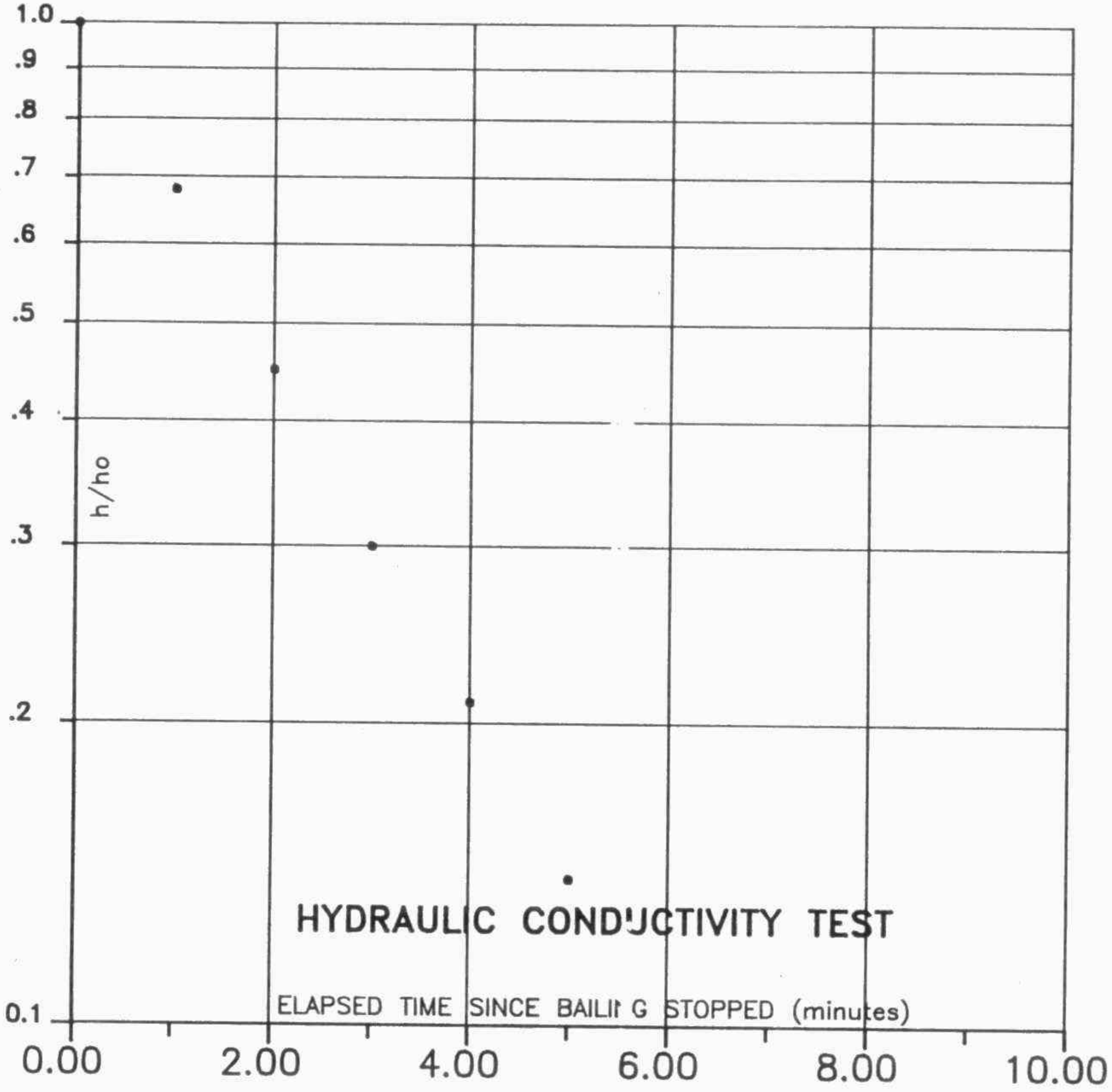
HYDRAULIC CONDUCTIVITY TEST

WELL No. OW 1–5
STATIC LEVEL: 3.09m b.m.p.
TEST DATE: JANUARY 11, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628–881

morrison beatty limited
consulting engineers and hydrogeologists

F–2



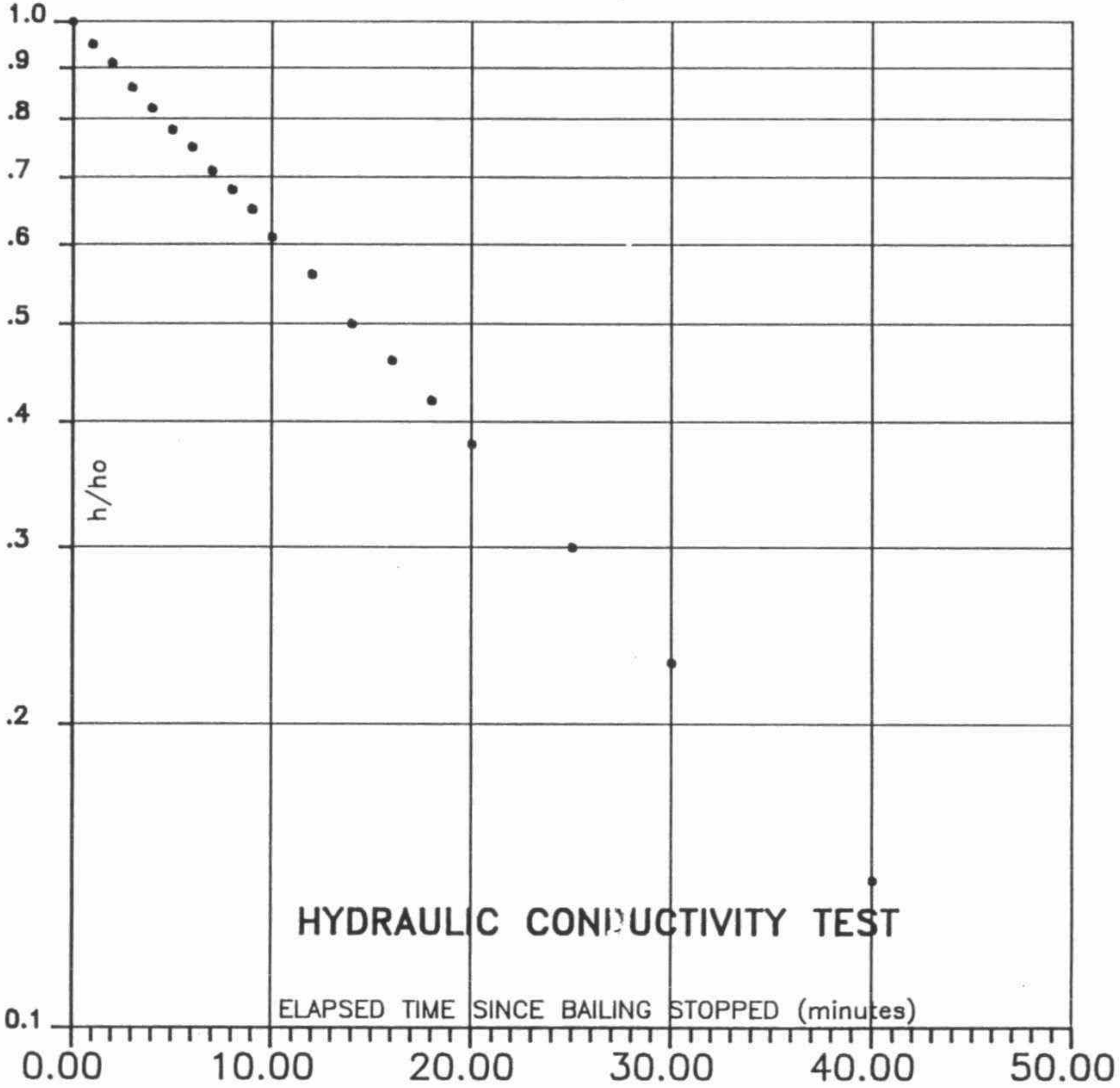
HYDRAULIC CONDUCTIVITY TEST

WELL No. OW 1-8
STATIC LEVEL: 3.19m b.m.p.
TEST DATE: JANUARY 11, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628-881

morrison beatty limited
consulting engineers and hydrogeologists

F-3

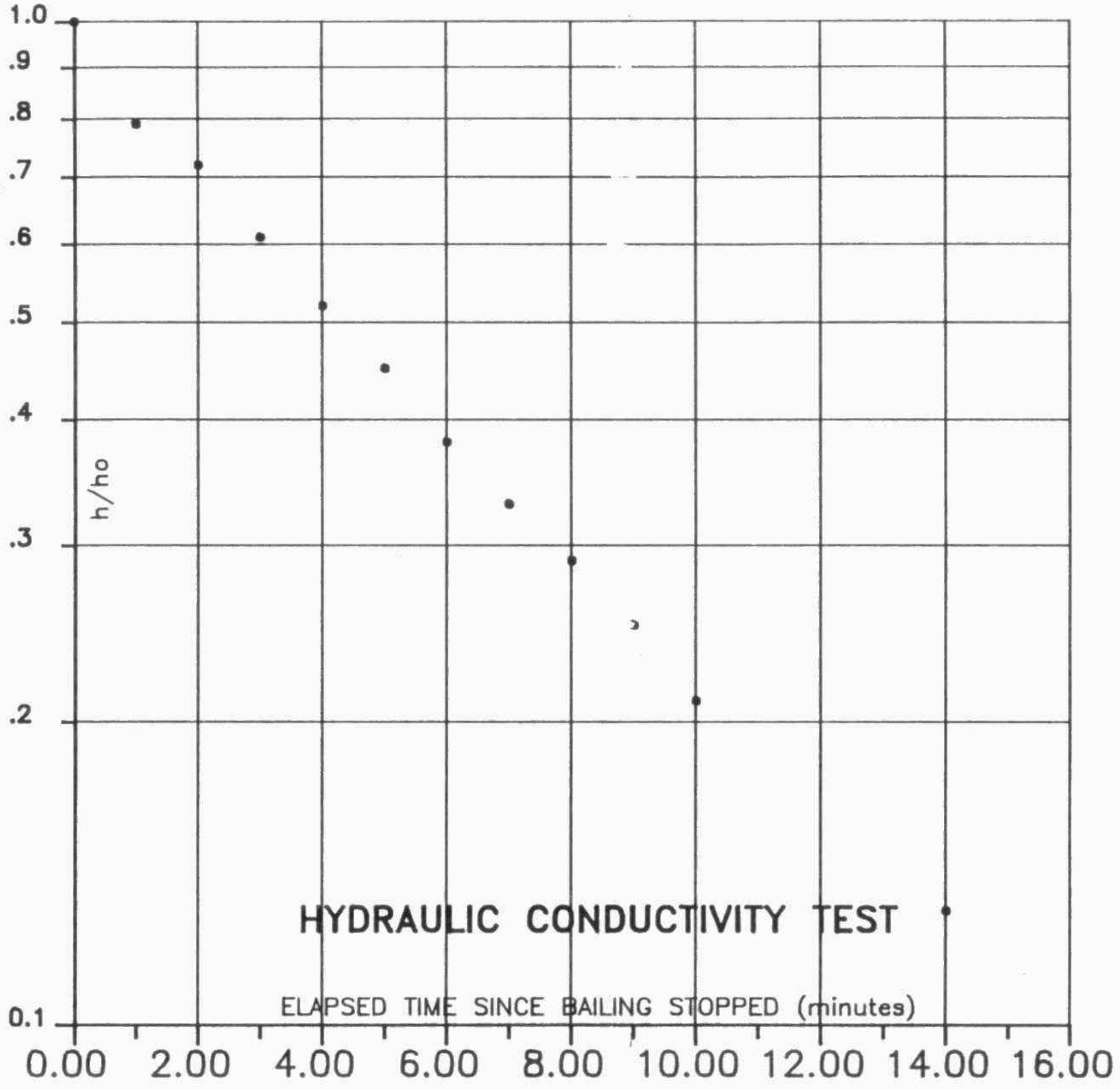


WELL No. OW 1-13
STATIC LEVEL: 3.48m b.m.p.
TEST DATE: JANUARY 11, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628-881

morrison beatty limited
consulting engineers and hydrogeologists

F-4

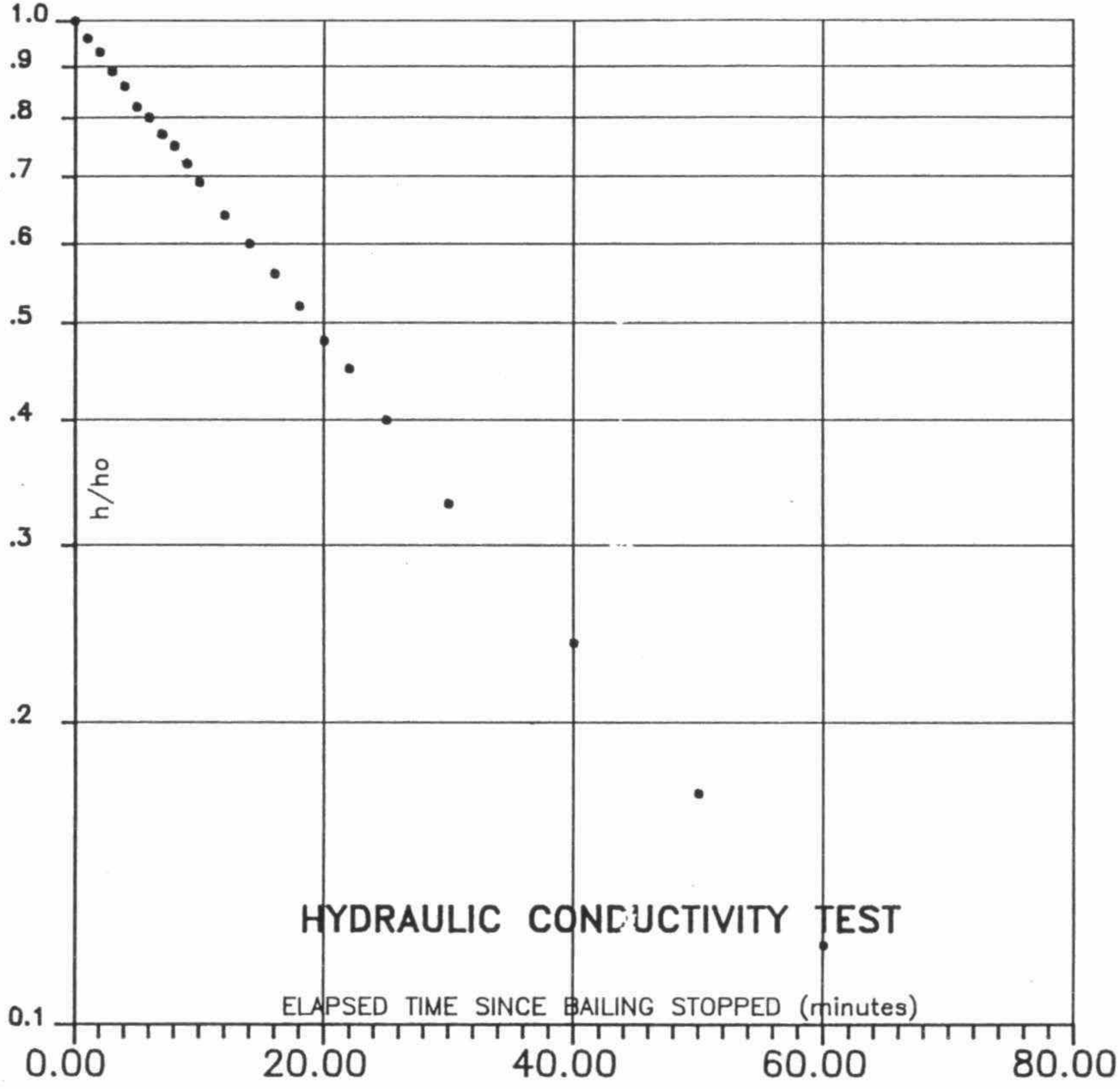


WELL No. OW 2-8
STATIC LEVEL: 5.30m b.m.p.
TEST DATE: JANUARY 11, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628-88

morrison beatty limited
consulting engineers and hydrogeologists

F-5

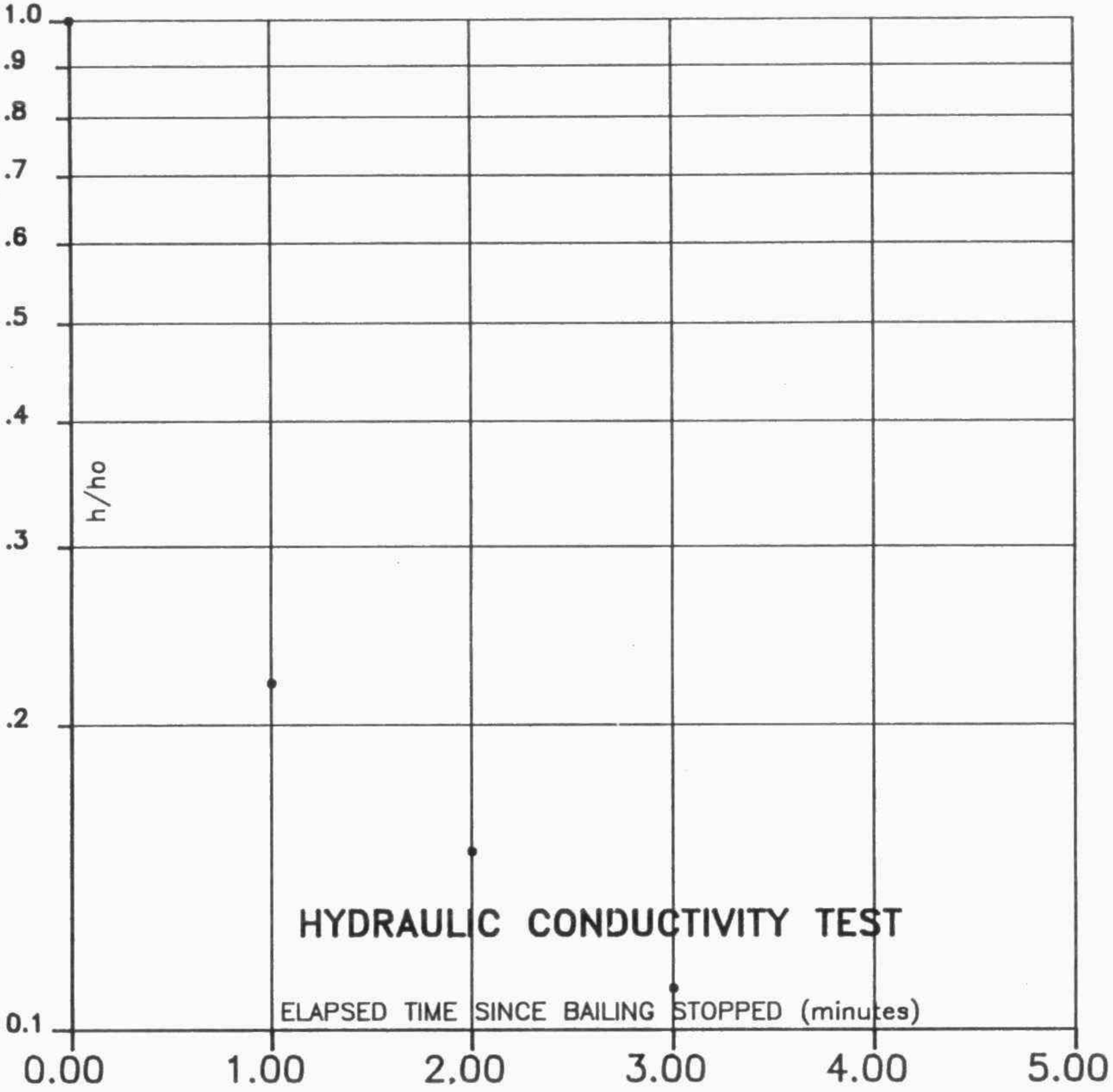


WELL No. OW 2-12
STATIC LEVEL: 5.62m b.m.p.
TEST DATE: JANUARY 11, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628-881

morrison beatty limited
consulting engineers and hydrogeologists

F-6

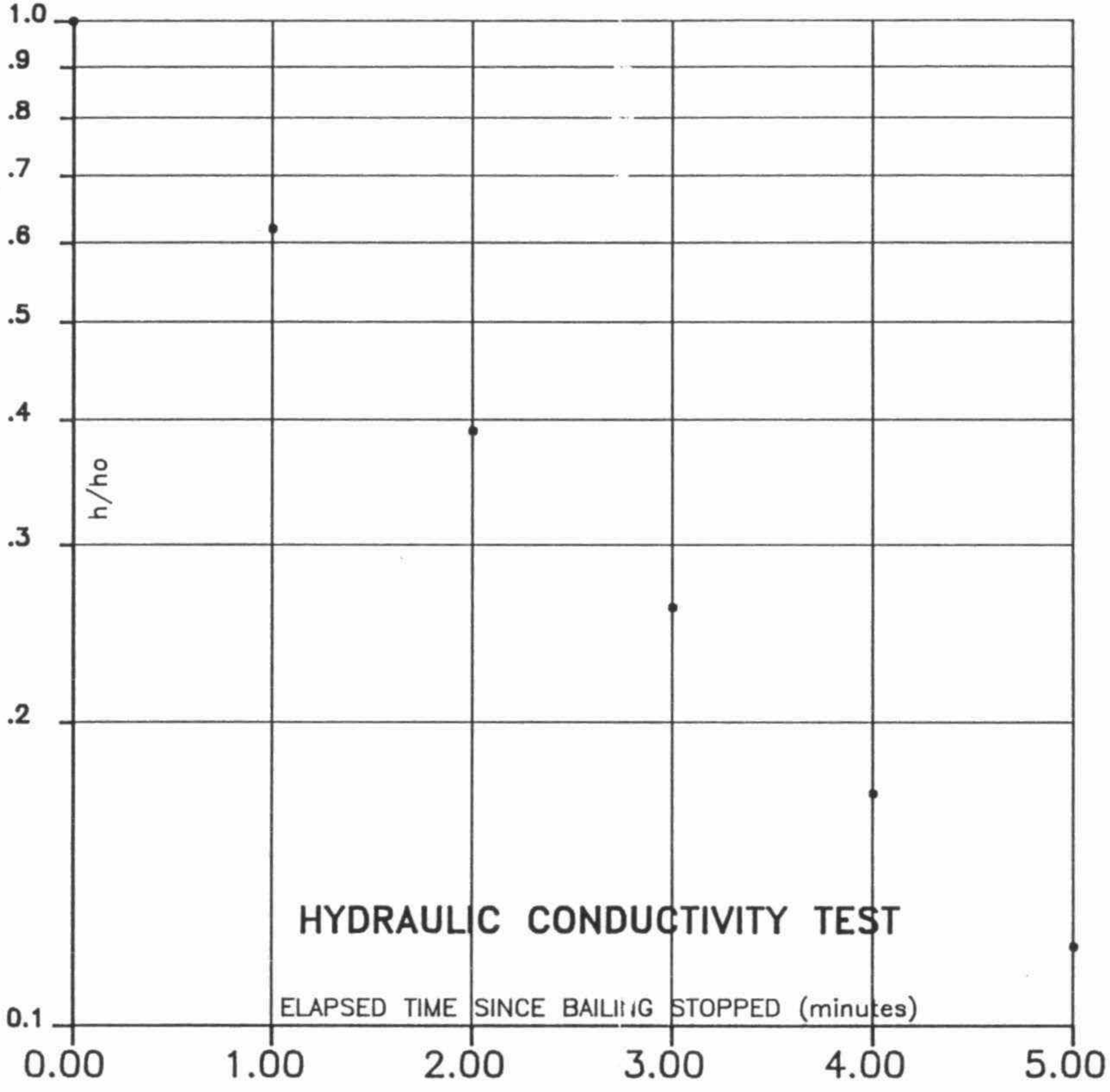


WELL No. OW 3-6
STATIC LEVEL: 4.20m b.m.p.
TEST DATE: JANUARY 12, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628-881

morrison beatty limited
consulting engineers and hydrogeologists

F-7



HYDRAULIC CONDUCTIVITY TEST

WELL No. OW 4-8
STATIC LEVEL: 3.03m b.m.p.
TEST DATE: JANUARY 12, 1989

MOE – WASTE MANAGEMENT BRANCH
CLOSED LANDFILL STUDY
EMSDALE LANDFILL
PROJECT NO. 628-881

morrison beatty limited
consulting engineers and hydrogeologists

F-8

TABLE F-2

WATER LEVEL ELEVATIONS

Well #	Measuring Point Elevations		Approximate Geodetic Water Level Elevtaions*				
	Relative Elev.	Assumed Geodetic Elev.*	Dec. 3/88	Dec. 4/88	Dec. 5/88	Jan. 9/89	Jan. 10/89
1-5	101.77	353.64	351.85	NA	NA	350.63	350.63
1-8	101.89	353.75	351.85	NA	NA	350.63	350.63
1-13	101.90	353.76	351.53	NA	NA	350.33	350.33
2-8	103.84	355.71	351.08	NA	NA	350.47	350.47
2-12	103.75	355.60	350.84	NA	NA	350.01	350.01
3-6	113.25	365.12	NA	361.72	NA	NA	360.92
4-8	99.62	351.48	NA	NA	349.11	NA	348.52

* Elevations based on a Temporary Bench Mark established on site. Elevation of the TBM assumed at 100.0 m converted to an assumed geodetic elevation of 351.86 m

WATER CHEMISTRY

APPENDIX G

BARRINGER LABORATORIES

14-Feb-89

MORRISON BEATTY LIMITED
4500 Dixie Rd.
Unit 12 A
Mississauga, ON L4W 1V7, Canada

Page: 1
Copy: 1 of 1
Set : 1

Authority: Mr. Dave Sawicki
Project : 628.881 Purchase order :

Job: 894022 Status: Final

Type	Sample	F- IC mg/L	Cl- IC mg/L	NO2-N IC mg/L
water	OW-1-5	0.16	7.61	<0.02
	OW-1-8	<0.01	0.93	<0.02
	OW-1-13	<0.01	0.97	<0.02
	OW-2-8	<0.01	0.41	<0.02
	OW-2-12	<0.01	1.16	<0.02
	OW-3-6	<0.01	0.40	<0.02
	OW-4-8	<0.01	0.41	<0.02
	Duplicate	<0.01	0.62	<0.02
	Blank	<0.01	<0.01	<0.02
	QC Standard (actual)	0.21	5.00	1.06
	QC Standard (expected)	0.20	5.00	1.00
	Repeat OW-1-5	0.16	7.53	<0.02

BARRINGER LABORATORIES

14-Feb-89

MORRISON BEATTY LIMITED
4500 Dixie Rd.
Unit 12 A
Mississauga, ON L4W 1V7, Canada

Page: 2
Copy: 1 of 1
Set : 1

Authority: Mr. Dave Sawicki
Project : 628.881
Purchase order :

Job: 894022
Status: Final

Type	Sample	PO4-3 IC mg/L	Br- IC mg/L	NO3-N IC mg/L	SO4= IC mg/L	Phenols 4-AAP ug/L	pH pH Elec. pH Units
water	OW-1-5	1.0	<0.05	0.47	18.46	<0.5	8.09
	OW-1-8	<0.1	<0.05	0.56	10.19	1.0	6.48
	OW-1-13	<0.1	<0.05	0.98	13.59	<0.5	6.83
	OW-2-8	<0.1	<0.05	0.18	7.02	<0.5	6.29
	OW-2-12	<0.1	<0.05	0.16	18.26	<0.5	6.75
	OW-3-6	<0.1	<0.05	0.11	6.36	<0.5	6.41
	OW-4-8	<0.1	<0.05	0.22	10.24	<0.5	6.56
	Duplicate	<0.1	<0.05	0.36	13.40	<0.5	7.20
	Blank	<0.1	<0.05	<0.02	<0.05	<0.5	5.60
	QC Standard (actual)	2.5	0.99	1.95	20.51	10.0	4.48
	QC Standard (expected)	2.5	1.00	2.00	20.00	10.0	4.45
	Repeat OW-1-5	1.3	<0.05	0.46	18.22	<0.5	7.93

BARRINGER LABORATORIES

14-Feb-89

MORRISON BEATTY LIMITED
4500 Dixie Rd.
Unit 12 A
Mississauga, ON L4W 1V7, Canada

Page: 3
Copy: 1 of 1
Set : 1

Authority: Mr. Dave Sawicki
Project : 628.881
Purchase order :

Job: 894022
Status: Final

Type	Sample	Tot. Alk. Titr. 1 mg CaCO3/L	TKN A. Col. mg/L	NH3-N A. Col. mg/L	DOC A. Col. mg/L
water	OW-1-5	79	0.21	<0.02	3.0
	OW-1-8	31	0.08	<0.02	0.7
	OW-1-13	31	0.03	<0.02	0.6
	OW-2-8	11	0.12	<0.02	0.6
	OW-2-12	31	0.15	<0.02	1.0
	OW-3-6	14	0.10	0.03	0.9
	OW-4-8	18	0.05	<0.02	0.2
	Duplicate	31	0.05	<0.02	0.4
	Blank	2	<0.02	<0.02	<0.2
	QC Standard (actual)	52	1.43	0.32	9.7
	QC Standard (expected)	50	1.40	0.30	10.0
	Repeat OW-1-5	79	0.18	<0.02	3.2

Authority: Mr. Dave Sawicki
Project : 628.881 Purchase order :

Job: 894022 Status: Final

Abbreviations:

Analyses:

F- : Fluoride ion concentration
Cl- : Chloride ion concentration
NO2-N : Nitrite ion concentration expressed as nitrogen
PO4-3 : Phosphate ion concentration
Br- : Bromide ion concentration
NO3-N : Nitrate ion concentration expressed as nitrogen
SO4= : Total Sulphate ion concentration
Phenols : Phenolic compounds determined using the 4-AAP method
pH : pH using a standard electrode system
Tot. Alk. : Total alkalinity by titration to pH 4.5
TKN : Total Kjeldahl Nitrogen (Tot. N minus NO2-N & NO3-N)
NH3-N : Ammonia concentration expressed as nitrogen
DOC : Dissolved Organic Carbon

Methods:

IC : Ion Chromatography
4-AAP : Colourimetry using 4-AAP method
pH Elec. : Standard pH electrode and meter used
Titr. 1 : Titration with standardized H2SO4
A. Col. : Automated Colourimetry

Units:

mg/L : Milligrams per Liter - used for liquids
ug/L : Micrograms per liter - used for liquids
pH Units : Usual units for pH measurement
mg CaCO3/L : Expressed as equivalent milligrams CaCO3 per Liter

Quality control:

< : Result obtained was below the detection limit

Signed: A. Love
....
Agnes Love, B.Sc.
Supervisor, Environmental Inorganic Services

BARRINGER LABORATORIES LT

FILE: T9_4022
DATE: 08/02/89
MATRIX: AQUEOUS

MORRISON BEATTY (DAVE SAWICKI) PROJ:628.881 WO NO: 89-4022

SAMPLE ID	AG MG/L	AL MG/L	B MG/L	BA MG/L	BE MG/L	CA MG/L	CD MG/L	CO MG/L	CR MG/L
OW-1-5	<.01	673	.335	6.66	.012	108	<.02	.1	.26
OW-1-8	.011	.93	.075	.043	<.0005	3.92	<.01	<.05	<.01
OW-1-13	<.005	1.18	<.004	.049	<.0005	9.82	<.01	<.05	<.01
OW-2-8	.009	.31	<.004	.038	<.0005	3.51	<.01	<.05	<.01
OW-2-12	.006	.42	<.004	.052	<.0005	7.94	<.01	<.05	<.01
OW-3-6	.010	30.8	<.004	.934	.0010	14.2	<.01	<.05	.02
OW-4-8	.024	5.23	<.004	.251	<.0005	8.99	<.01	<.05	<.01
DUPLICATE	.005	1.34	<.004	.054	<.0005	9.70	<.01	<.05	<.01
CONTROL DATA	--	--	--	--	--	--	--	--	--
BLANK	<.005	<.01	<.004	<.005	<.0005	.04	<.01	<.05	<.01
OW-1-5	<.01	673	.336	6.66	.012	108	<.02	.1	.26
OW-1-5-R	<.01	687	.336	7.18	.012	109	<.02	.2	.28
CONTROL STD	<.005	1.01	.201	1.04	.0189	.09	.19	.20	.21
CONTROL.EST.	--	1.00	.200	--	.0200	--	.20	.20	.20

SAMPLE ID	CU MG/L	FE MG/L	K MG/L	MG MG/L	MN MG/L	MO MG/L	NA MG/L	NI MG/L	P MG/L
OW-1-5	.50	430	149	100	5.57	<.4	73	.4	8
OW-1-8	<.008	.88	2.6	1.21	.05	<.2	14.4	<.05	<.5
OW-1-13	.009	1.50	3.2	3.15	.05	<.2	6.5	<.05	<.5
OW-2-8	.041	.35	1.9	.78	.06	<.2	5.1	<.05	<.5
OW-2-12	<.008	.50	2.7	1.99	.07	<.2	11.7	<.05	<.5
OW-3-6	.103	21.5	6.5	16.1	.78	<.2	3.6	<.05	1.7
OW-4-8	.032	4.36	2.9	2.89	.12	<.2	4.4	<.05	.6
DUPLICATE	.012	1.81	3.3	3.17	.06	<.2	6.6	<.05	<.5
CONTROL DATA	--	--	--	--	--	--	--	--	--
BLANK	<.008	.02	<.5	<.01	<.01	<.2	<.5	<.05	<.5
OW-1-5	.50	430	149	100	5.57	<.4	73	.4	8
OW-1-5-R	.50	427	167	111	5.46	<.4	76	.3	8
CONTROL STD	.215	1.04	<.5	<.01	.20	<.2	<.5	.23	<.5
CONTROL.EST.	.200	1.00	--	--	.20	--	--	.20	--

SAMPLE ID	PB MG/L	SI MG/L	SR MG/L	TH MG/L	TI MG/L	V MG/L	ZN MG/L	ZR MG/L
OW-1-5	<1.00	61.6	1.26	.3	16.4	.28	1.07	.2
OW-1-8	<.05	8.18	.048	<.05	.029	.008	<.01	<.05
OW-1-13	<.05	13.9	.082	.06	.065	.020	.02	<.05
OW-2-8	<.05	5.35	.045	.06	.005	<.005	.03	<.05
OW-2-12	<.05	10.7	.065	<.05	.012	.008	<.01	<.05
OW-3-6	<.05	26.7	.122	.07	158	.060	.15	<.05
OW-4-8	<.05	17.2	.093	<.05	.082	.024	.04	<.05
DUPLICATE	<.05	14.6	.082	<.05	118	.024	.02	<.05
CONTROL DATA	--	--	--	--	--	--	--	--
BLANK	<.05	<.05	<.001	<.05	<.005	<.005	<.01	<.05
OW-1-5	<1.00	61.7	1.26	.3	16.4	.28	1.07	.2
OW-1-5-R	<1.00	64.3	1.33	.3	17.6	.35	1.05	.1
CONTROL STD	.41	<.05	.200	<.05	.192	.200	.22	.19
CONTROL.EST.	.40	--	.200	--	.200	.200	.20	.20

GROUND WATER QUALITY

Table G-1

CLIENT:MORRISON BEATTY LTD. DATE: 18-Jan-88
W.O. # 89-4022
MATRIX:WATER

VOLATILE ORGANICS RESULTS (EPA 624) ND = NOT DETECTED

	COMPOUND	M.D.L. UG/L	OW1-13	OW1-13 REPEAT	DUPLICATE
1	CHLOROMETHANE	2.0	ND	ND	ND
2	VINYL CHLORIDE	2.0	ND	ND	ND
3	BROMOMETHANE	2.0	ND	ND	ND
4	CHLOROETHANE	5.0	ND	ND	ND
5	TRICHLOROFLUOROMETHANE	1.0	ND	ND	ND
6	1,1-DICHLOROETHENE	0.5	ND	ND	ND
7	DICHLOROMETHANE	1.5	ND	ND	ND
8	TRANS-1,2-DICHLOROETHENE	0.2	ND	ND	ND
9	1,1-DICHLOROETHANE	0.2	ND	ND	ND
10	CHLOROFORM	0.2	ND	ND	ND
11	1,1,1-TRICHLOROETHANE	0.2	ND	ND	ND
12	CARBON TETRACHLORIDE	0.2	ND	ND	ND
13	BENZENE	0.1	ND	ND	ND
14	1,2-DICHLOROETHANE	0.2	ND	ND	ND
15	TRICHLOROETHENE	0.2	ND	ND	ND
16	1,2-DICHLOROPROPANE	0.2	ND	ND	ND
17	BROMODICHLOROMETHANE	0.2	ND	ND	ND
18	CIS-1,3-DICHLOROPROPENE	0.5	ND	ND	ND
19	TOLUENE	0.2	ND	ND	ND
20	TRANS-1,3-DICHLOROPROPENE	0.5	ND	ND	ND
21	1,1,2-TRICHLOROETHANE	1.0	ND	ND	ND
22	TETRACHLOROETHENE	0.5	ND	ND	ND
23	DIBROMOCHLOROMETHANE	1.0	ND	ND	ND
24	CHLOROBENZENE	0.2	ND	ND	ND
25	ETHYLBENZENE	0.2	ND	ND	ND
26	M-XYLENE & P-XYLENE	0.2	ND	ND	ND
27	O-XYLENE	0.2	ND	ND	ND
28	BROMOFORM	2.0	ND	ND	ND
29	1,1,2,2-TETRACHLOROETHANE	1.0	ND	ND	ND
30	1,3-DICHLOROBENZENE	0.2	ND	ND	ND
31	1,4-DICHLOROBENZENE	0.2	ND	ND	ND
32	1,2-DICHLOROBENZENE	0.2	ND	ND	ND

	SURROGATE STANDARD RECOVERIES:	AMOUNT			
33	1-CHLORO-2-BROMOPROPANE	10 UG/L	75%	118%	117%
34	1,4-DICHLOROBUTANE	10 UG/L	98%	94%	93%
35	4-BROMOFLUOROBENZENE	2 UG/L	99%	97%	99%

BARRINGER LABORATORIES

CLIENT:MORRISON BEATTY
W.O. # 89-4022A
MATRIX:WATER

DATE: 30-Jan-89

ACID-EXTRACTABLES RESULTS (EPA 625)   ND = NOT DETECTED

	COMPOUND	M.D.L. UG/L	REAGENT BLANK	OW-1-13	OW-1-13 REPEAT	DUPLICATE
1	PHENOL	0.5	ND	ND	ND	ND
2	2-CHLOROPHENOL	0.5	ND	ND	ND	ND
3	2-NITROPHENOL	0.5	ND	ND	ND	ND
4	2,4-DIMETHYLPHENOL	0.5	ND	ND	ND	ND
5	2,4-DICHLOROPHENOL	0.5	ND	ND	ND	ND
6	4-CHLORO-3-METHYL PHENOL	0.5	ND	ND	ND	ND
7	2,4,6-TRICHLOROPHENOL	0.5	ND	ND	ND	ND
8	2,4-DINITROPHENOL	5.0	ND	ND	ND	ND
9	4-NITROPHENOL	2.0	ND	ND	ND	ND
10	2-METHYL-4,6-DINITROPHENOL	5.0	ND	ND	ND	ND
11	PENTACHLOROPHENOL	2.0	ND	ND	ND	ND

	SURROGATE STANDARD RECOVERIES:	AMOUNT SPIKED				
12	A,A,A-TRIFLUORO-M-CRESOL	25 UG/L	54%	112%	93%	100%
13	1,2,3-TRIBROMOPHENOL	25 UG/L	52%	107%	82%	120%

BARRINGER LABORATORIES

CLIENT:MORRISON BEATTY
W.O. # 89-4022A
MATRIX:WATER

DATE: 30-Jan-89

SPIKED ACID EXTRACTABLES SAMPLES - PERCENT RECOVERY

	COMPOUND	AMOUNT UG/L	REAGENT BLANK
1	PHENOL	25	40%
2	2-CHLOROPHENOL	25	71%
3	2-NITROPHENOL	25	65%
4	2,4-DIMETHYLPHENOL	25	49%
5	2,4-DICHLOROPHENOL	25	67%
6	4-CHLORO-3-METHYL PHENOL	25	69%
7	2,4,6-TRICHLOROPHENOL	25	72%
8	2,4-DINITROPHENOL	25	39%
9	4-NITROPHENOL	25	27%
10	2-METHYL-4,6-DINITROPHENOL	25	65%
11	PENTACHLOROPHENOL	25	64%

SURROGATE STANDARD RECOVERIES:

	COMPOUND	AMOUNT UG/L	REAGENT BLANK
12	A,A,A-TRIFLUORO-M-CRESOL	25	146%
13	1,2,3-TRIBROMOPHENOL	25	140%

CLIENT:MORRISON BEATTY LIMITED JANUARY 27, 1989
W.O. # 89-4022
MATRIX:WATER

ANALYSIS FOR PCB'S ND=NOT DETECTED

SAMPLE IDENTIFICATION	DETECTION LIMIT UG/L	TOTAL PCB'S UG/L
REAGENT BLANK	0.01	ND
OW-1-13	0.01	ND
OW-1-13(REPEAT)	0.01	ND
DUPLICATE	0.01	ND

PERCENT RECOVERIES OF SPIKED SAMPLES

	SPIKED AMOUNT UG/L	TOTAL PCB'S RECOVERED PERCENT
REAGENT BLANK	0.25	90.2%

TABLE G-2

IONIC BALANCE

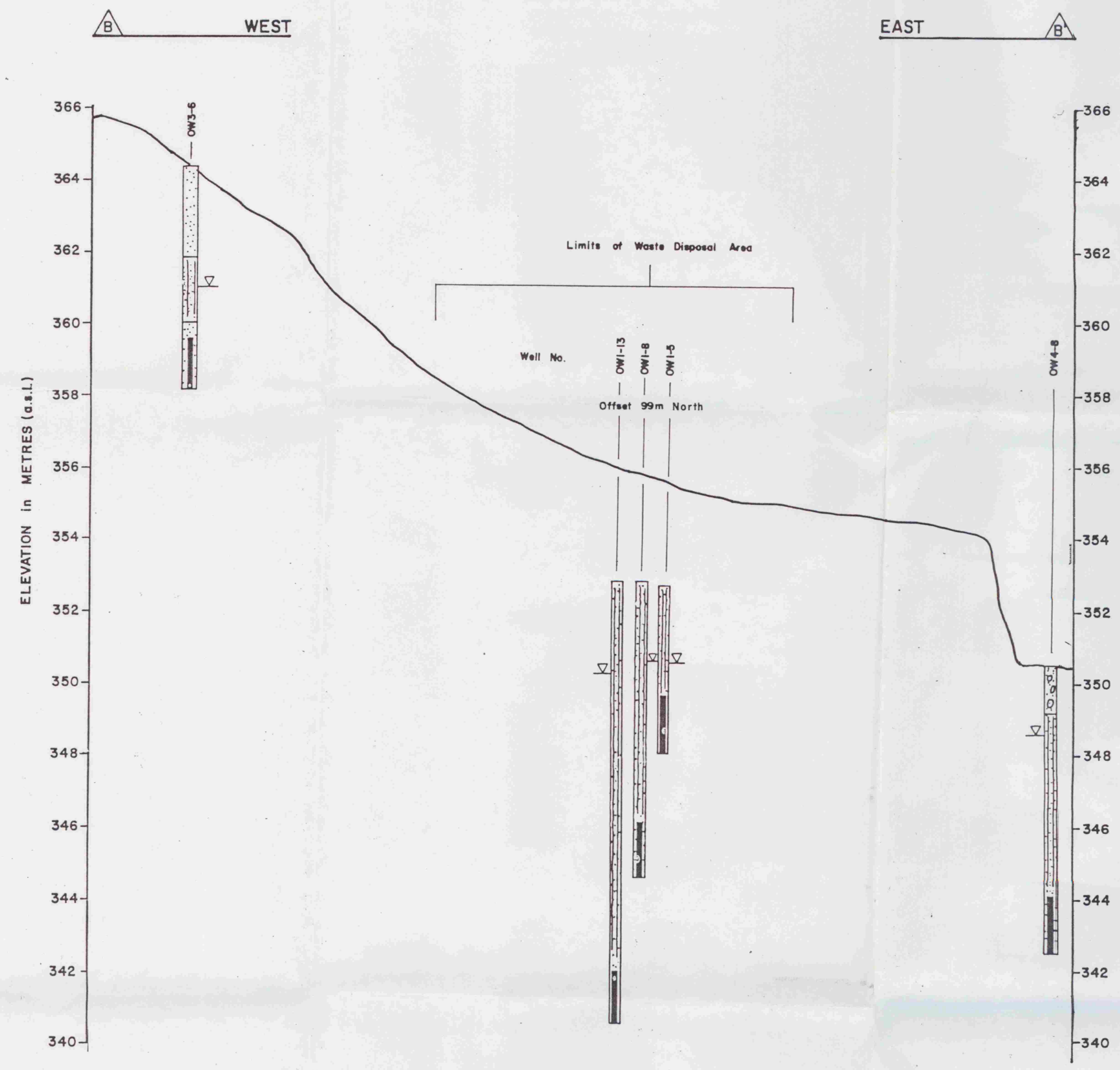
Well No.	Cations (epm)	Anions (epm)	Difference %
1-5	20.599	2.179	89.4
1-8	0.899	0.858	4.6
1-13	1.120	0.930	170
2-8	0.510	0.378	26.0
2-12	1.082	1.033	4.7
3-6	2.365	0.423	82.0
4-8	0.952	0.585	63.0

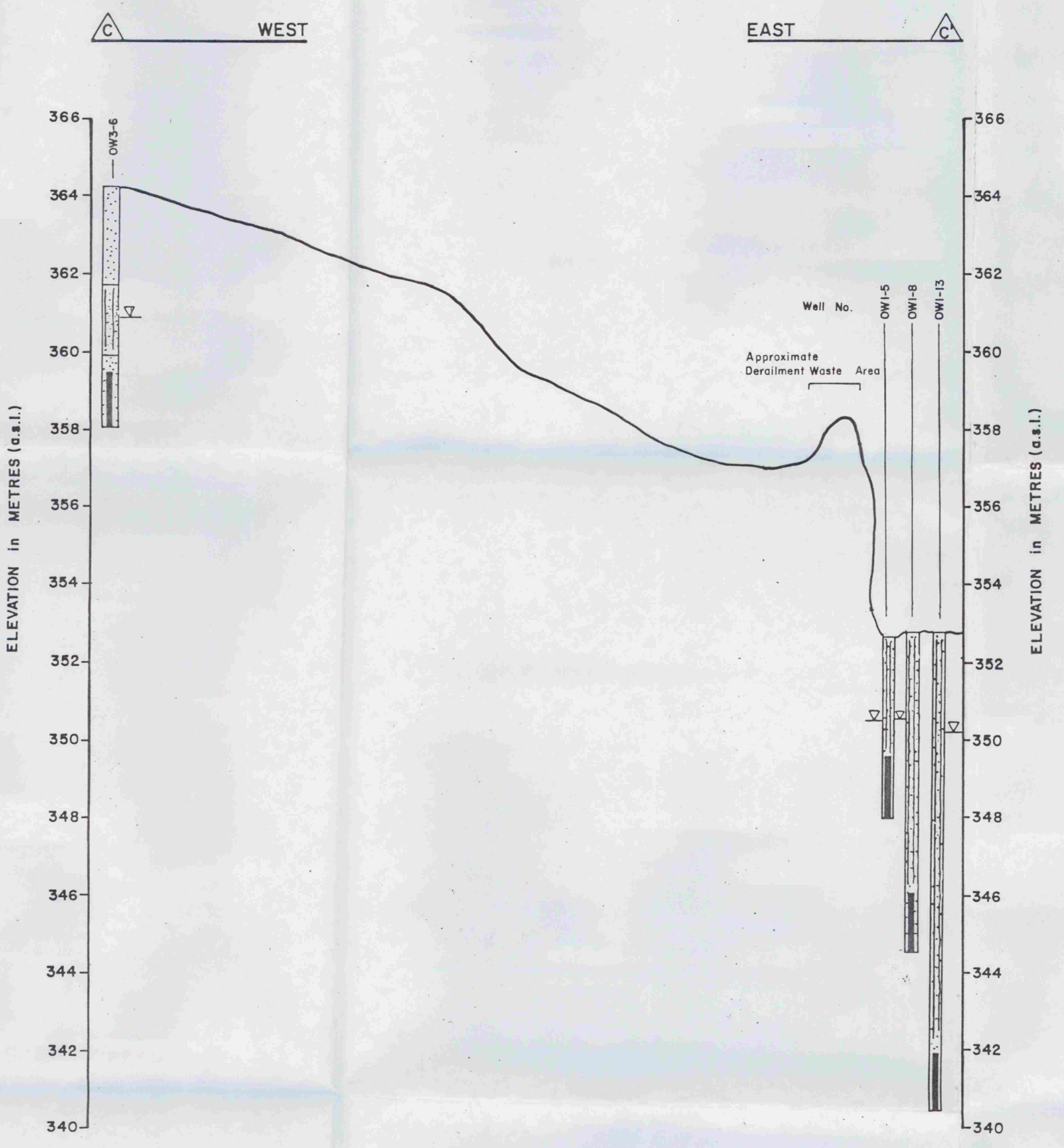
TABLE G-3

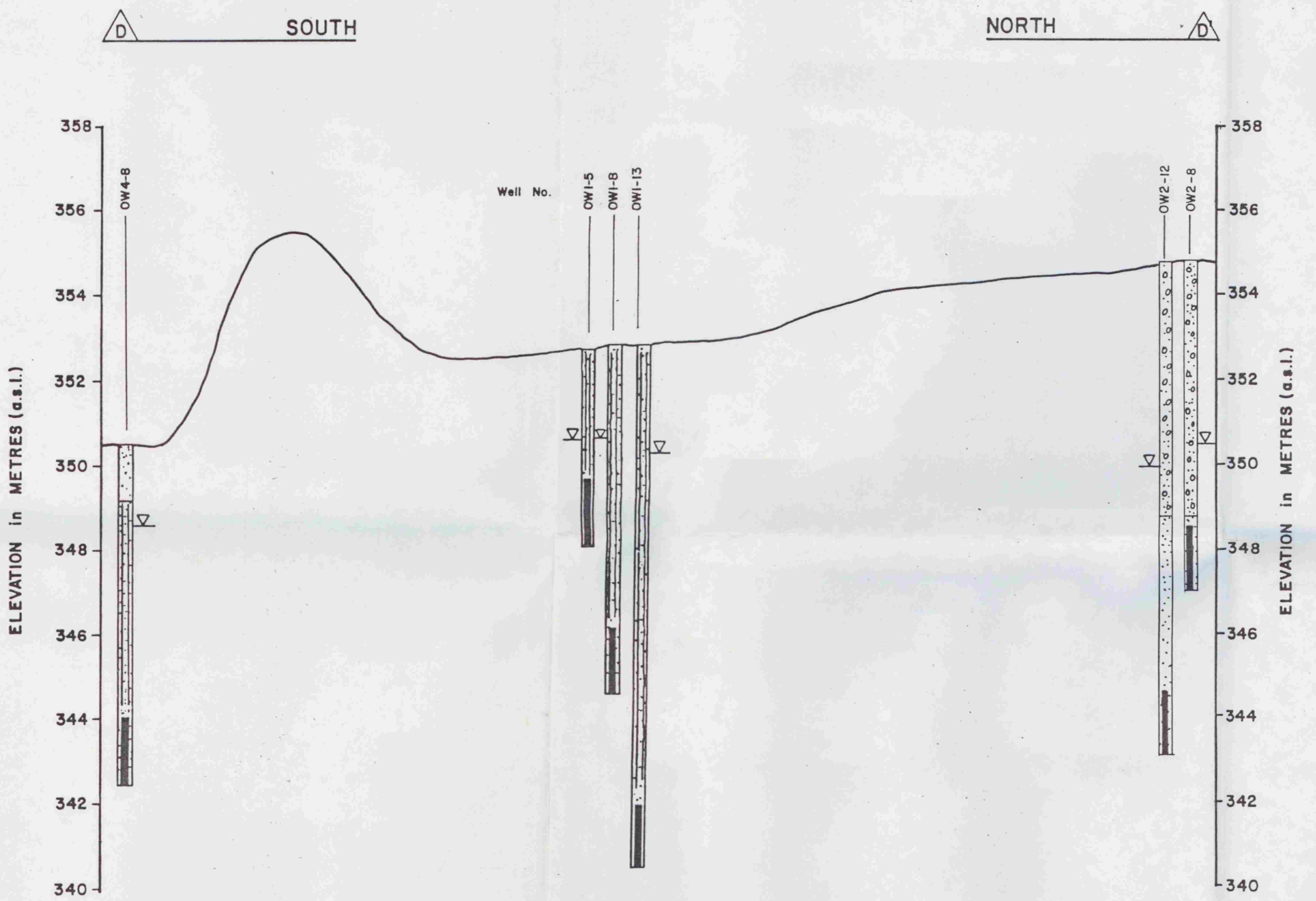
PRIVATE WELL CHEMISTRY

(Field Testing Results)

Well#	Name	Conductivity (umho/cm)	Temperature °C	pH	Alkalinity (mg/L)
11	Fetterley	250	17.0	5.9	86
12	D. Marshall	90	15.5	5.9	34
13	Hughes	350	15.0	5.9	34
6	Stoher	130	15.0	6.5	103
14	Gilpin	120	15.0	6.2	69
15	E. Marshall	42	16.0	6.2	17
16	Warehouse	107	16.3	6.2	51
17	Stanley	60	17.0	6.2	34
18	Powell	112	19.0	5.9	34
19	Nolan (Control)	150	[illegible].9	5.9-6.2	103







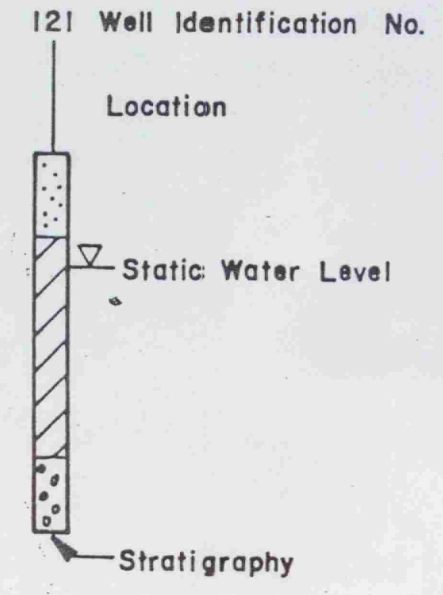
LEGEND

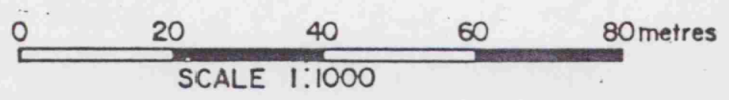
▥ SILT

░ SAND

⁘ GRAVEL

▮ SCREENED INTERVAL





SCALE 1:1000

VERTICAL EXAGGERATION = 1

NOTE: GEODETIC ELEVATIONS ESTIMATED FROM NTS 31E/11. ON SITE ELEVATIONS DETERMINED FROM SITE SURVEY USING A TEMPORARY BENCH MARK WITH ASSUMED ELEVATION 100m. THE RELATIVE ELEVATION HAS BEEN CONVERTED TO AN ESTIMATED GEODETIC ELEVATION.

EMSDALE
CLOSED LANDFILL SITE
MoE Waste Management Branch

SITE STRATIGRAPHIC CROSS SECTIONS
B-B', C-C', D-D',

PROJECT No. 628-881

FEB., 1989

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416-624-8306)

7